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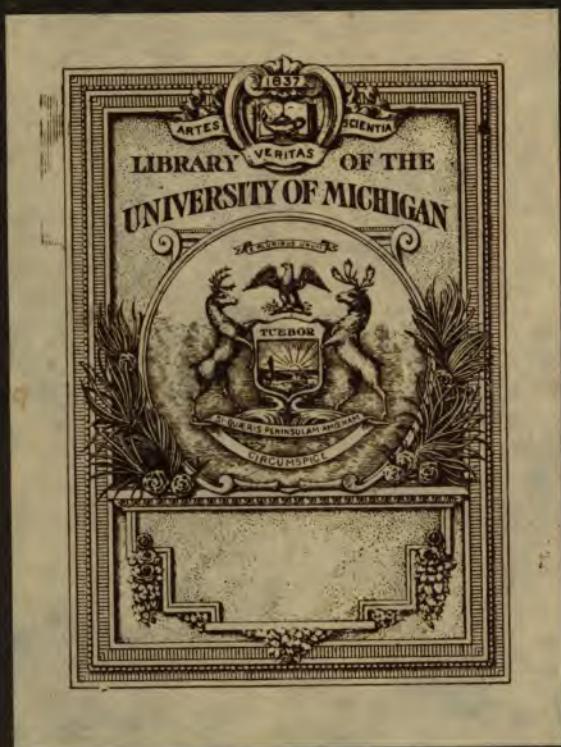
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INDUSTRIES AND ELECTRICITY

IN THE

STATE OF SÃO PAULO
BRAZIL

BY

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INDUSTRIES AND ELECTRICITY IN THE STATE OF SÃO PAULO BRAZIL

THE state of S. Paulo embraces that portion of Brazil lying immediately south of Rio de Janeiro, having a coast line of about 260 miles, and extending inland toward the north-west for a distance of 390 miles. Among the twenty states of Brazil, S. Paulo ranks ninth in size, second in population, and first in wealth. The tropic passes through the city of S. Paulo, a small portion of the state lying in the temperate zone and the rest in the torrid. There are several harbors along the coast, of which the most famous is Santos. Only a few miles inland is the Serra do Mar, having an altitude of 2700 feet above the sea-level, running parallel with the coast and forming the watershed of the state. All the streams rising beyond it flow toward the interior and mingle their waters with the great Paraná, and eventually reach the ocean at Buenos Ayres. These streams, rising in the eastern mountain region and finding their way over the plateau sloping toward the west, drain some of the finest

agricultural regions of the continent. At the same time they furnish abundant water power for the development of great manufacturing industries. The state for the most part is rolling, and has a considerable elevation above the sea-level, which gives it a climate that is on the whole temperate. As is the case in most tropical regions, the rainfall is abundant and vegetation luxuriant. Agriculture is the great industry of the state, though only a third of its territory has yet been occupied, and the fertile soil liberally rewards the labor bestowed upon it. As to the mineral wealth imbedded beneath the soil, our knowledge is still very limited. With the increase of population and extension of the home market, manufacturing interests are bound to develop and invite large investments of native and foreign capital.

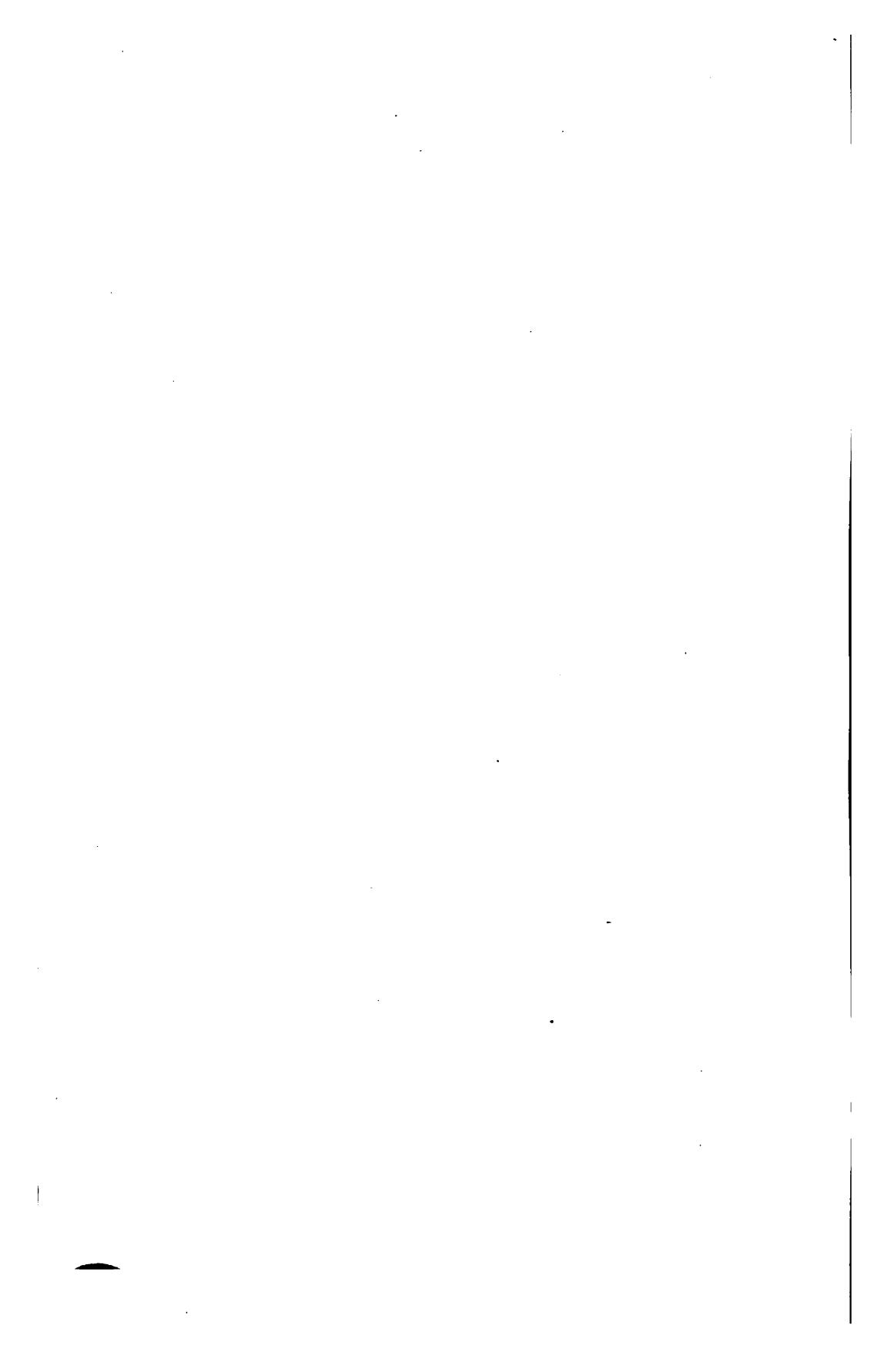
I. AGRICULTURE

Coffee

The world's production of coffee last year amounted in round numbers to $19\frac{1}{2}$ million bags. Of this amount Brazil produced 16 million, 10 million of which came from the state of S. Paulo. This state is thus shown to be the greatest coffee-growing region on the globe. Java, Arabia and Guatemala do not rival S. Paulo in extent of territory or richness of soil adapted to the cultivation of coffee. As a consequence, almost the entire population of the state is in some way connected with the coffee business. The number of laborers engaged in the several industries of S. Paulo is estimated at 450,000. Of this number, an army of 420,000 is employed in the production and transportation of coffee. About 85 % of the capital invested in the industries of the state is involved in the coffee business and the railroads dependent on coffee.



COFFEE TREES IN BLOOM,
"SANTA ADELAIDE" FAZENDA, NEAR RIBEIRÃO PRETO.



The State Department of Agriculture estimates the area actually planted in coffee at 1,908,000 acres, belonging to 15,800 different proprietors; whereas the total area of land in the state well adapted to its cultivation is not less than 4,585,000 acres. As the world's demand for coffee increases, it is clear that S. Paulo is abundantly able to furnish the supply, both by cultivating more of the land adapted to coffee and by greater care of that already under cultivation. (11)

The number of trees in this state now bearing coffee attains to figures hard to comprehend. A careful study of the subject places them at 545,000,000! As the people of the United States are, as a nation, the greatest coffee drinkers in the world, it may be a source of some satisfaction to them to know that S. Paulo has nearly 7 coffee trees for every American man, woman, and child, to say nothing of an additional 140,000,000 trees under four years of age which will supply the demand of the coming generation.

The value of a coffee plantation, including houses for laborers, pasture, gardens, etc., is determined by the number of coffee trees on it, and their productiveness. The average tree that has begun to bear is valued at about 50 cents, and the young tree less than four years old, at 25 cents. On this basis the coffee plantations of S. Paulo have a value of not less than \$312,000,000!

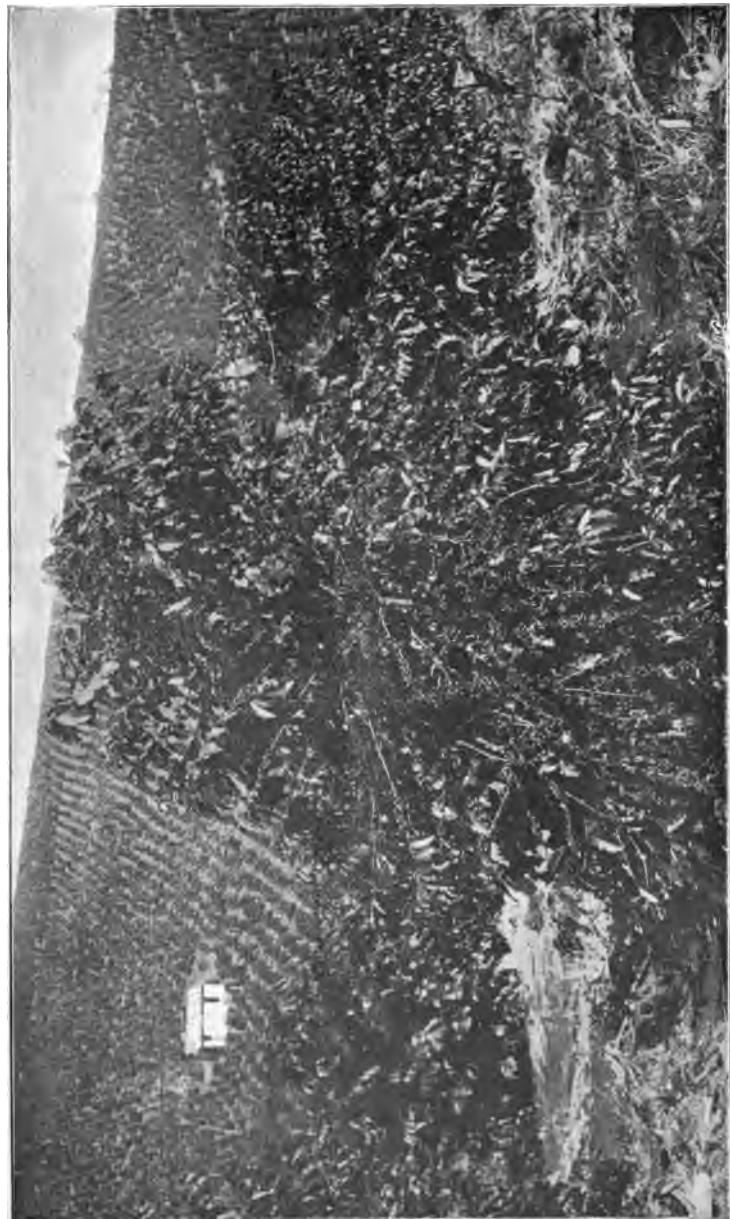
The annual yield of the trees varies greatly with the quality of the soil, the amount of rainfall, etc. It is generally expected that in a good year the average 1000 trees shall yield about 2310 pounds of coffee. Calculating on this basis we arrive at 10 million bags for the state, which was the amount produced last year. The number of trees will also correspond to the figures given above.

The value of a coffee crop depends very largely on the manner in which it is cared for and prepared for the market. Hence the interest that attaches to every process from the time that picking begins, until the bags of coffee are put into freight cars and started to Santos whence they are shipped.

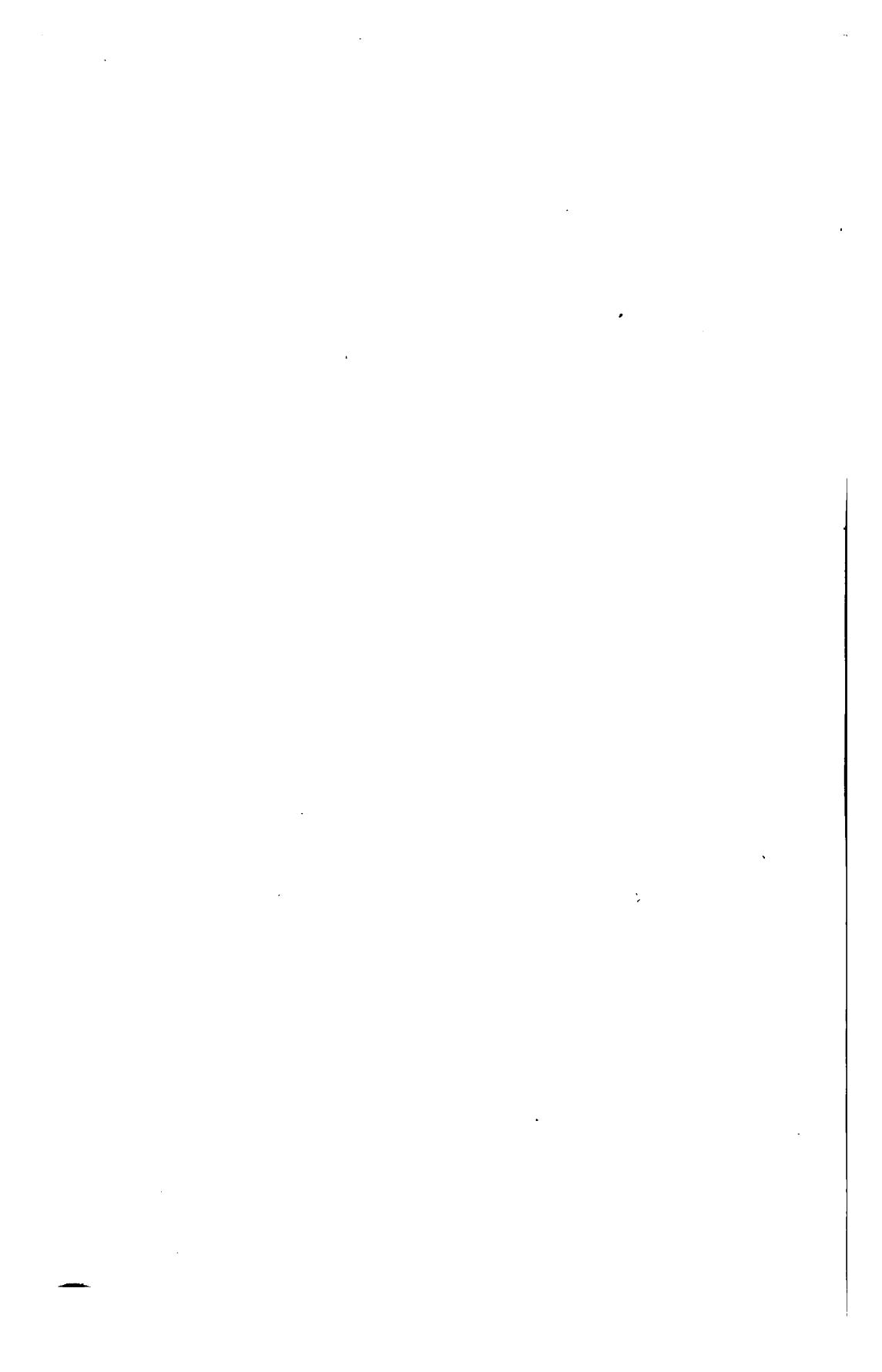
to the most distant lands. The different processes that coffee must undergo are numerous, and it is a crop that requires more care than cotton or wheat.

Coffee ripens and the picking season begins in the month of May. It is then that every available laborer is needed, and can obtain employment. The rush is not unlike that during the wheat harvest in Kansas, or the cotton picking season in the Southern States of North America. The limbs are stripped of the berries which fall on the ground and literally cover the surface beneath the trees. The berries are then gathered up and hauled in carts to the place prepared for washing them. As a large amount of water is needed, the washing is done near a stream. The berries are separated from the dirt, stones, leaves, etc., and are spread out to dry on a large drying ground. This is the first of the processes requiring special care. Coffee loses much of its value if poorly dried. On small plantations the drying ground is rolled and beaten hard, or perhaps covered with a layer of pitch. On the large coffee estates, terraces are built and paved with either glazed brick or cement. This of course requires considerable capital. Among the most widely known of these large estates may be mentioned the following: the Dumont Fazenda, belonging to the Dumont Company, this being the largest coffee plantation in the world; the Iracema and the Monte Alegre Fazendas, belonging to Francisco Schmidt, the largest proprietor of coffee plantations in the world; the São Martinho Fazenda, owned by the Prado family; and the Santa Genebra Fazenda, owned by Baron Geraldo de Rezende. The first four of these fazendas are situated far in the interior of the state, near the town of Ribeirão Preto, while the last named is not far from Campinas. The drying terraces of the Iracema Fazenda occupy more than 10 acres and are valued at some \$75,000.

The length of time required for drying the coffee varies according to the weather. Under a hot sun five or six days suffice; if rain interrupts, the drying process is sometimes a



COFFEE TREES BEFORE PICKING. "SANTA ADELAIDE" FAZENDA, NEAR RIBEIRÃO PRETO.
BELONGING TO SENHOR ARTHUR DIEDRICHSEN.



matter of weeks, as the laborers are compelled to take in the coffee and put it out again with the return of favorable weather. If this operation has to be repeated often, there is little profit left for the coffee-grower. To meet this difficulty a special apparatus has been invented for drying the coffee artificially. Those who use this apparatus consider it advisable to sun the coffee at least a day or two before submitting it to artificial heat. It is a known fact that coffee loses one half of its moisture the first day or two, if there is good sun. By having it half dry to begin with, there is a saving of half the fuel that would otherwise be required.

About 75 fazendas are equipped for drying coffee artificially. Four kinds of drying apparatus are in use. One kind, called the «Augusto», is employed on 58 fazendas; another kind, the «Arens» on 11; while 5 fazendas are supplied with either the «Guichard» or the «Tournay & Telles». The last named is old and has been employed on the Santa Genebra Fazenda since 1884. The capacity of these «dryers» varies considerably, The Augusto will dry as much as 130 bushels a day, provided the coffee shall previously have been in the sun three or four days, as is the practice on the St. Adelaide Fazenda which produces about 10,000 bags of coffee each year.

If on the drying grounds one square yard of surface serves on an average for drying what amounts to 22 pounds of pure coffee, the surface required for drying the annual crop of S. Paulo is 9884 acres, or about $15 \frac{1}{2}$ square miles. When thoroughly dry the coffee is stowed away in large warehouses where it remains for weeks or months, sometimes even for a year.

Hulling is the next process to which coffee is subjected. It may follow any time after the coffee has been dried. Hulling is to coffee very much what threshing is to wheat. Its object is to get the clean bean separated from the case in which it is inclosed. The machines employed in S. Paulo to hull coffee number thousands. Each of the large fazendas mentioned above has its own type of hulling machine. They

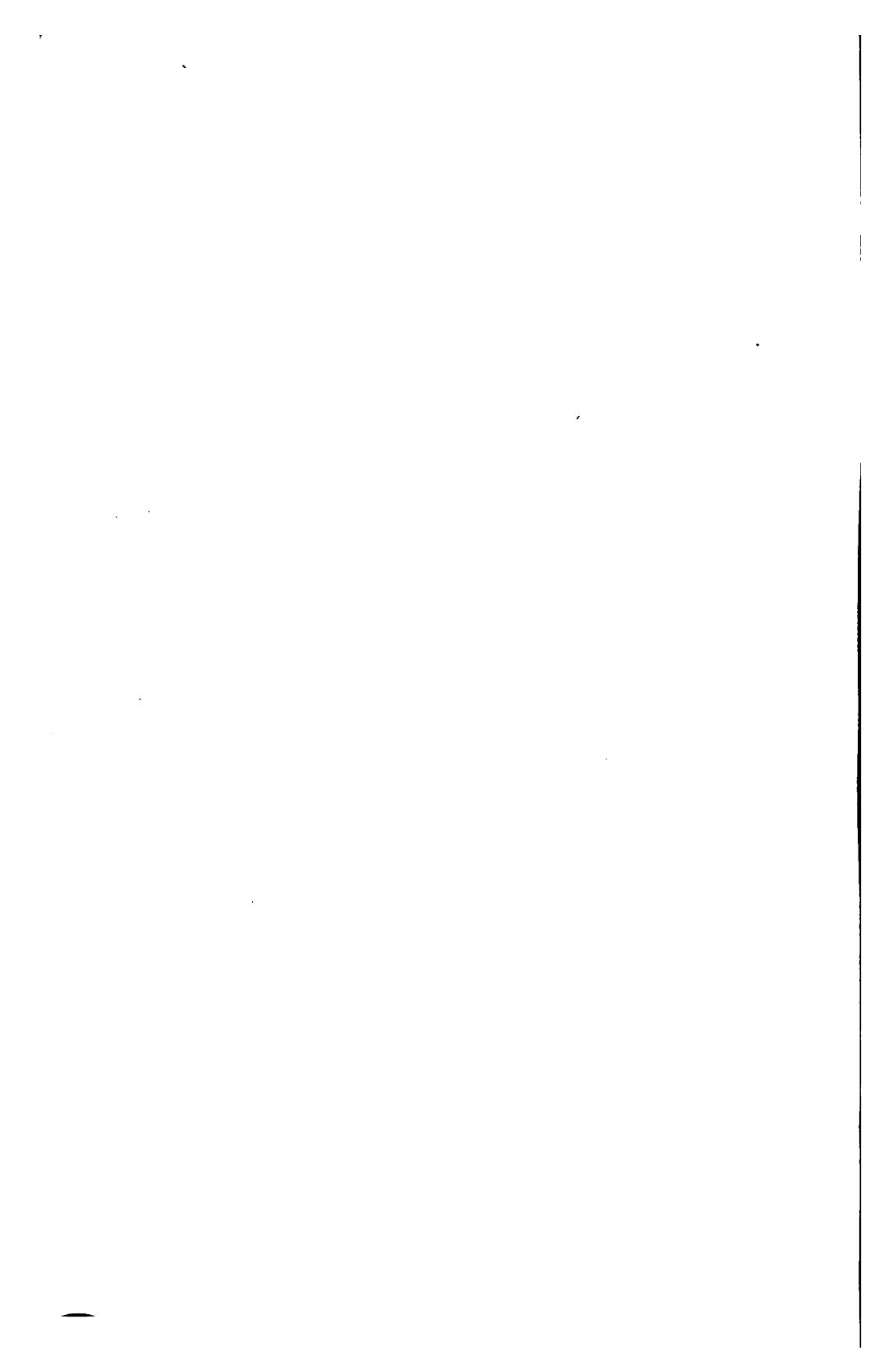
all do their work by crushing the dried berry between the iron receptacle and a spring or bar rubbing against it. Some of these receptacles are cylindrical in form, others conical, and still others are disks. The hulling machines vary in capacity. Some of them will hull as much as 250 bags of coffee a day. In some cases steam is the motive power used to run these machines, in others water. The average machine requires less than 8 horse-power. The Engelberg, the Lidgerwood, the Mac-Hardy, and the Arens are the machines most commonly employed. They have fans which drive away the dry husks and leave the pure bean ready for the separator.

It was formerly the custom in some localities to polish the coffee bean so as to give it a more attractive appearance. This was done by means of a rubbing process, for which there were various kinds of machines. In view of the exigencies of the market this process has generally been abandoned.

The next and last process is that of sorting the beans. As the value of this great staple depends so largely on the beans' being properly classified, the coffee-grower gives the most careful attention to this process. The principle on which the separating is carried out is the size and shape of the bean. The Java, the Mocha, the Rio, and numerous other brands of coffee all grow on the same tree, some near the trunk, others near the extremities of the branches. It is the business of the separator to distribute into the several grades the coffee that has been hulled and cleaned. There are several kinds of machines for this purpose in use. The most of them consist of a horizontal revolving cylinder. The sides of this cylinder are perforated plates—a sort of metallic net, the meshes of which vary in form and dimensions according to the size and shape of the beans to be separated. The «Monitor», a separator recently put on the market by the Companhia Mechanica, has an alternating, rectilineal movement, and instead of the cylinder a set of sieves is employed. Lidgerwood, Arens, and Mac-Hardy all make separators that are in common use on the fazendas.



“COLONIA NOVA”: STARTING EARLY IN THE MORNING TO PICK COFFEE.
“SANTA ADELAIDE” FAZENDA, NEAR RIBEIRÃO PRETO.



The several processes described above constitute what is known as the « dry system » of preparing coffee for the market, and is the one commonly in use in this state. There is, however, another series of processes that constitute what is called the « wet system », which is adopted to some extent. The wet system has the advantage of being easier of application than the other, provided water is abundant, though the results are not so satisfactory. According to this system the first process is that of freeing the bean from its hull and pulp. — a process known as pulping. Only a thin skin or parchment then remains around the bean. There are various kinds of pulping machines in use, the most of which are made by the four large factories already mentioned, which make a large variety of machinery for agricultural and industrial purposes. Some of these machines pulp as much as 1650 bushels a day, though this is the exception.

Pulping is followed by a fermenting process intended to free the coffee from mucilaginous matter not removed by the pulping machine. Fermentation is carried out in tanks and vessels made for the purpose, and requires many hours. The coffee is dried, sometimes polished, and then sorted, just as in the dry system.

When the coffee has been duly sorted, it is ready to ship. Roasting and grinding are operations left to the consumer to carry out according to his taste. In cities like São Paulo, Campinas, Santos, etc., there are large roasting establishments to meet the demands of local trade.

It remains to speak of the motive power employed in the state of S. Paulo in carrying out the several processes necessary to prepare coffee for the market. On many fazendas water power is at hand, though steam is more commonly used. As to the amount of power needed, we may take the Santa Genebra Fazenda as an average. There a 38 horse-power engine cleans as much as 6500 bags; that is, 175 for each horse-power. On this bases the coffee crop of the state in the year 1901-02 required 57,000 horse-power to hull,

clean, and sort the coffee. On some fazendas stationary engines are employed, on others, portable engines. The fuel used in general is the dry husk of the coffee, so that coal and wood are not required.

A coffee fazenda is a little community by itself, and in many respects may be compared to the old-time plantation in the Southern States of North America. The number of laborers living on a large fazenda depends on its size, varying from 500 to 3000. They are called "colonos", and a great many privileges are granted them by the proprietor, such as garden, pasture, the right to plant beans and corn between the rows of coffee trees, etc. The number of fowls, dogs, goats, cows and mules sometimes reaches far into the thousands.

In some cases agents of the large buyers in Santos go to the fazendas and buy the coffee on the spot. Then the proprietor is relieved of all anxiety about hauling the coffee to the railroad station, shipping it to Santos, and selling it. In other cases the coffee is shipped to Santos and sold there. The Santos market is ruled by the New York and the Havre markets, as these two cities import more coffee than any others in the world. Other cities that import large quantities from Brazil are Hamburg, Rotterdam, Genoa, Southampton, and New Orleans. Of the 10 million bags produced in São Paulo in 1901-02, 3 millions were consumed in the United States.

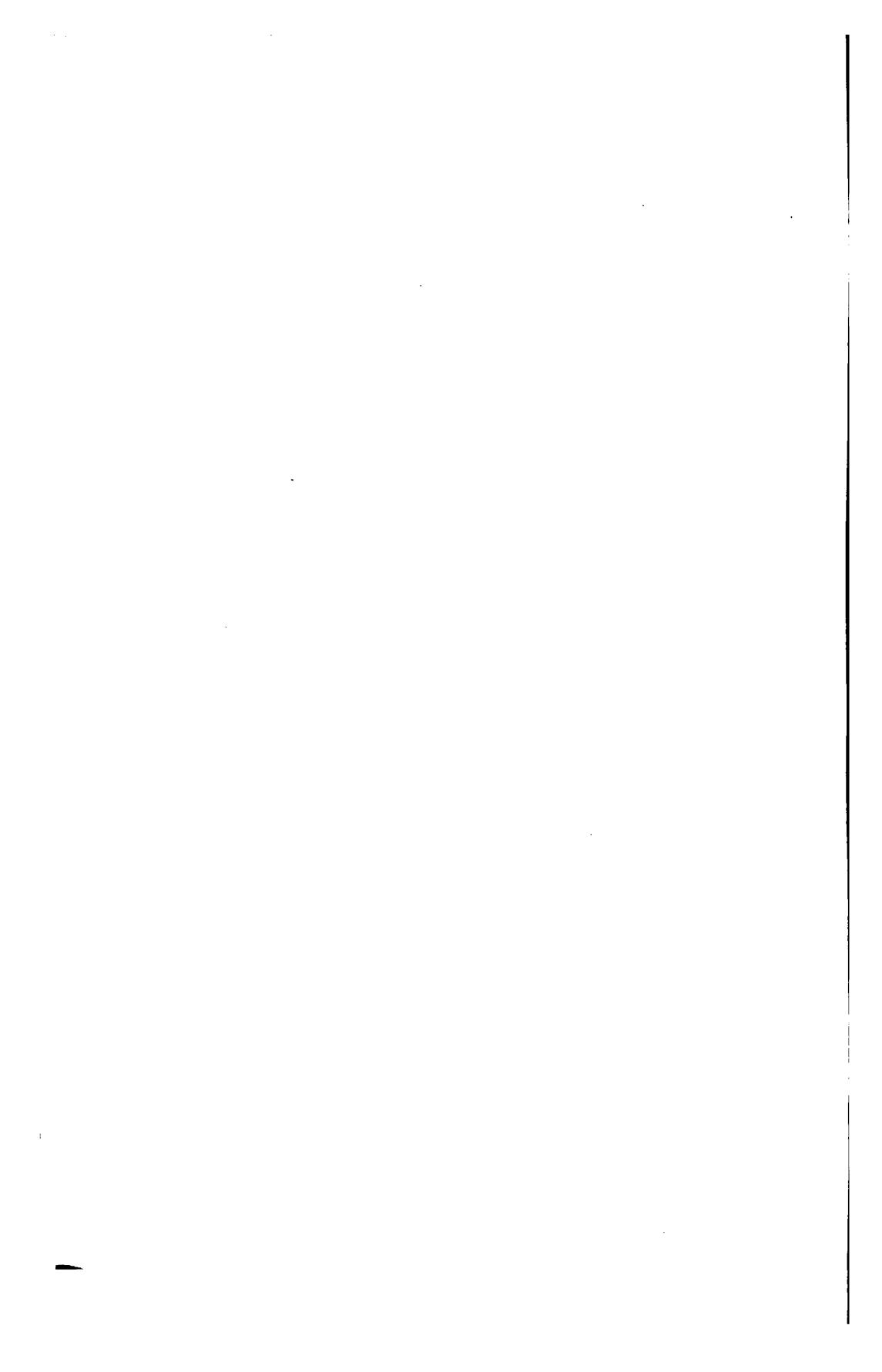
These, in brief, are the facts concerning Brazil's greatest industry and source of wealth.

Sugar

When compared with coffee, sugar-growing is still among the infant industries of the state, though it is one with large possibilities. The surface and climate of S. Paulo are so varied that considerable areas are well adapted to the cultivation of sugar cane, especially the lower and damper



PICKING COFFEE.
“SANTA ADELAIDE” FAZENDA BELONGING TO SNR. ARTHUR DIEDRICHSEN, NEAR RIBEIRÃO PRETO.



sections. The state now produces annually about 13,300 tons ¹⁾, which must be supplemented by importing from other states four times this amount, in order to supply the market of the state. This estimate of the production of sugar does not include the output of the small mills on hundreds of fazendas, operated merely to supply families residing in the vicinity.

The juice is extracted by passing the cane between heavy iron cylinders, operated in many cases by hydraulic motors, though more commonly by steam. The machinery used in the several processes of sugar-making is much the same as in the other great sugar-growing countries of the world. There are 9 large establishments which use the vacuum evaporator, some of which grind about 42,000 tons of cane a year. The sugar obtained amounts to more than 8 % of the weight of the cane. The cost of production, including cultivation and making, in many sections does not exceed \$37.50 a ton, which is less than 2 cents a pound. If an acre of land produces $1\frac{3}{5}$ tons (which is a rather low estimate), the land planted in cane in S. Paulo must be about 17,300 acres. The capital invested in sugar mills amounts to \$3,000,000, and some 6,000 laborers are employed. In order to carry the cane from the fields to the mills, a large number of cheap railroads of narrow gauge have been constructed.

Sugar refineries are found throughout the state. Very frequently a sort of triple industry exists, in which the same establishment refines sugar, roasts coffee, and grinds salt. The cities of S. Paulo and Campinas are the principal centers of the sugar refining business.

Alcohol and Rum

The manufacture of sugar yields alcohol as a by-product in such large quantities that the preparation of alcohol has

¹⁾ V. Pamphlet on "The Sugar Industry in S. Paulo", by Augusto Ramos, professor in the State Polytechnic School.

become an important industry in S. Paulo. Supposing that 4 gallons (21° Cartier) are produced for every ton of sugar, the crop of the state indicates a yield of some 53,000 gallons of alcohol. Besides the sugar factories there are a great many small establishments which make rum (aguardente) from the cane, but do not make sugar. These are generally operated by means of animal (mule or ox), though steam and water are frequently employed. There are also some large plants making rum on a great scale. The most important of these is at Funil and belongs to Arthur Nogueira & Co. It produces annually about 378,000 gallons. We may mention also the « Societé Anonyme de Distilleries Brésiliennes » located at Varzea on the S. Paulo Railway. This company distils from corn, and in this case pork is the by-product, as the residue of corn is used in fattening pigs.

There are establishments for rectifying the several alcoholic products, of which the most important is the « *Artigas and Comp.* »

The cost of producing alcohol is still relatively great, but is capable of being reduced to 24 cents a gallon by improved machinery and methods. When this is done, far greater quantities will doubtless be consumed in producing light, heat, and power; and the importation of coal will decline. In the city of S. Paulo even now the price of alcohol is sufficiently reasonable to enable it to compete advantageously with gas and petroleum. A German investigator endeavors to show that if alcohol is sold at 18 cents a gallon, a horse-power-hour (using alcohol) costs 11 cents. If this be true, certain localities of the state far removed from the coast can to-day use this product more cheaply than coal for generating power.

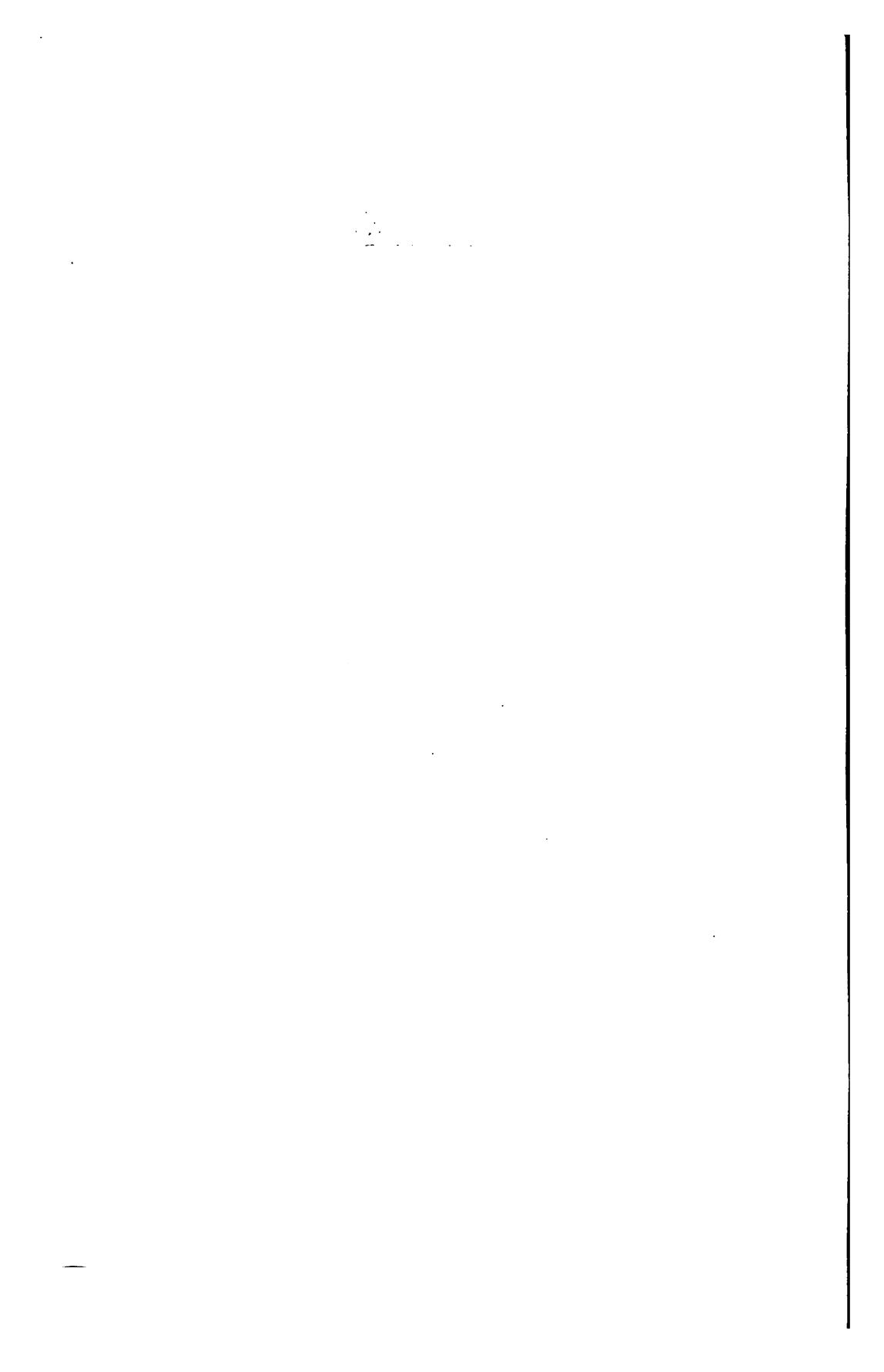
The capital invested in the alcohol industry in this state is something over half a million dollars.

Wine

The growing of grapes is another industry having great possibilities in S. Paulo. “Bread, meat, and wine”, says a



HAULING COFFEE FROM THE FIELD TO THE DRYING GROUNDS.
“SANTA ADELAÍDE” FAZENDA, NEAR RIBEIRÃO PRETO.



distinguished Brazilian, "is the watch-word necessary to attract immigration". The climate and soil are conducive to grape culture, and several varieties like the "Black July" and "Norton's Virginia" are extensively cultivated in certain communities. Chinese vines grafted into European perhaps yield the best results, as shown on the fazenda of Dr. Luiz Barreto at Pirituba. S. Bernardo is thus far the locality most widely known for its grapes, while Sorocaba excels in its wine-making establishments, being famous for its "Sangue Paulista" and "Caboclo". There are about 2 million vines now bearing grapes in this state, valued at \$1 each; while a quarter of a million dollars is invested in establishments for making wine. Ordinary wine can be produced at less than 15 cents a quart.

Cereals

There is scarcely a farm in the state on which corn is not cultivated. Nearly all the laborers and tenants on coffee fazendas raise the corn they need, frequently planting it between the rows of young coffee trees. There is abundance of rain and sunshine, so that this staple grows luxuriantly in the rich soil found over such large areas of the state, producing bread for man and forage for animals.

Rice is another cereal the cultivation of which is very general in S. Paulo. Certain sections like that around Iguape, have large areas planted in it. In spite of this fact rice is imported in considerable quantities from Japan and the Carolinas.

It is believed that wheat would grow well in the highlands of S. Paulo, but it is a great consumer of nitrogen and requires the land to be manured. As the stabling and feeding of cattle has not yet become common, the raising of wheat is not undertaken. It is believed that the state could produce bread enough for its people and to spare, if coffee did not absorb the attention of nearly the whole population.

Beans and Pease

Beans and pease are found on the market the year round. Almost every family on the coffee fazendas cultivates them and has them on the table every day of the year. They constitute one of the most important articles of food for both country and city population.

Dairy Products

In the state of S. Paulo are found vast plains, river valleys, and hillsides covered with grass, with abundance of water everywhere. It is a region where we should look for "the cattle upon a thousand hills". Insects injurious to cattle have never appeared, thus giving S. Paulo an advantage over certain districts in Northern Brazil. The cultivation of coffee, however, has absorbed the attention of the people, whereas they might be supplying Europe with beef. There are about 100,000 head of cattle in the state, found principally on the coffee fazendas to supply the families of the vicinity with milk, butter, and cheese. Goats are raised in much larger numbers for this purpose. Small cheese factories are found on many of the fazendas, which send some of their products to the city markets. Butter factories exist at Faxina, Itapetininga, Santa Barbara, and elsewhere, producing in all about 5500 pounds, whereas the city of S. Paulo alone consumes 19,000 pounds a month. The home supply has to be supplemented by bringing in large quantities from Minas Geraes, Rio de Janeiro, Santa Catharina and other states. Danish and French butter is also found on the market.

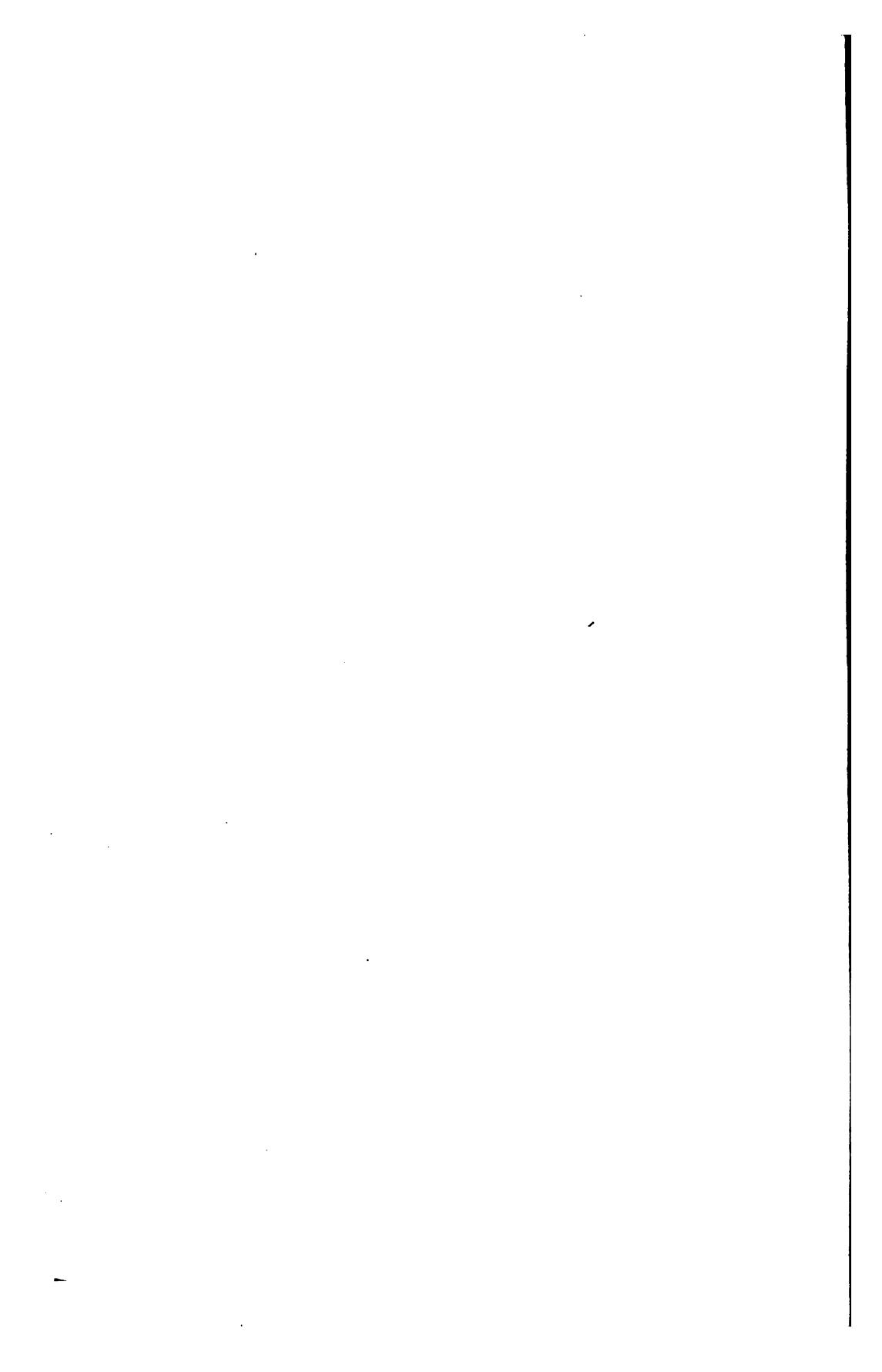
The cattle of the state have a value of about \$1,500,000, while the half million goats add another \$1,125,000.

Textile Fibres

Among the various soils and climates of this state cotton finds a home. In places the stalk grows as luxuriantly as in Texas, and the yield of lint is also large. The annual



STIRRING COFFEE WHILE DRYING.
"SANTA ADELAIDE" FAZENDA.



crop is about 24,000 bales (500 pounds each) which quantity can be greatly increased in time. The cotton produced here is not yet sufficient to supply the existing factories, so that considerable quantities are brought from other states.

Attention has recently been called to a new plant that is extremely interesting to all engaged in textile industries. Professor Augusto Carlos da Silva Telles, of the State Polytechnic School, has recently made experiments with a plant from which he extracted a fibre admirably adapted to weaving. The product is superior to jute fabrics in both appearance and durability, as shown by numerous experiments. This new fibre coming from a plant which grows wild in all parts of the state has been named «aramina» (little wire). Its cultivation has been undertaken, and there is evidence that it will yield 900 pounds of fibre to the acre. At Funil Arthur Nogueira & Co. had a crop this year amounting to 400,000 pounds, sufficient to weave 400,000 coffee bags. The weight of the fibre is from 7 to 8 % of the weight of the plant. The putting up of factories for weaving aramina is bound to be followed by the general cultivation of this interesting plant in all parts of this and other states. S. Paulo will exhibit at the Louisiana Purchase Exposition in St. Louis various articles made of aramina, such as coffee bags, curtains, carpets, ropes, canvas, tapestry, etc. When we remember the demand of manufacturers for textile fibres, and the great number of articles that can be made of aramina, what may we not expect in the future as to the extent of the cultivation of this plant on the rich plains and in the fertile valleys of S. Paulo?

The mulberry tree thrives in the moist soil on the hillsides of S. Paulo. The warm sun and abundant rainfall cause it to grow to a surprising size in a short time, while the foliage is as luxuriant as on the sunny slopes of Italy. Nature has provided everything necessary for the silkworm. At local fairs held in Campinas, Ribeirão Preto, and São Paulo some beautiful specimens of native silk have been on

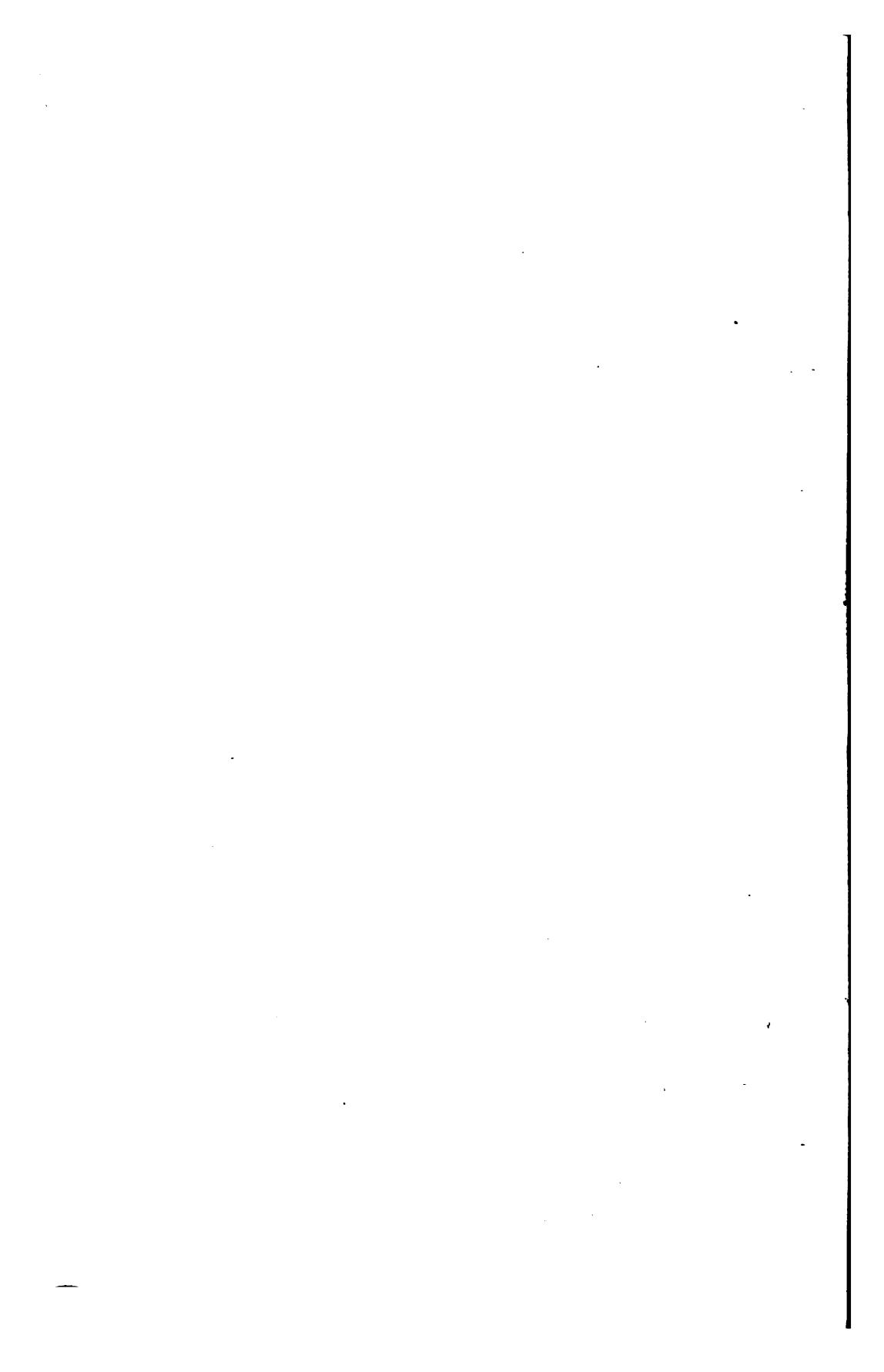
exhibition, which compare favorably with the best of the old world. This caused the state legislature to institute prizes to encourage the silk-growing and manufacturing industry, and the matter was commended to the earnest attention of the State Department of Agriculture.

The numerous kinds of soil, the variations in rainfall, the different altitudes above the sea-level make it possible to grow a large variety of crops advantageously in S. Paulo. This is first of all an agricultural state, and the several cities that have grown up owe their existence exclusively to this industry. But the demand of the world for coffee and the small supply furnished by other countries has made almost the entire population turn to that staple. It is the great article of export, the home consumption being relatively insignificant. The result is that the attention of the people has not yet been properly directed to the necessity of cultivating other crops and to the possibilities that lie along other lines.

The other crops mentioned serve to supply only a part of the home market, foreign products being imported to make up the deficiency. The area of the state is as great as that of Missouri and Illinois combined; all of it can be brought under cultivation, large sections of it being among the most fertile regions of the globe. As soon as the population, now over 2,000,000, turns its attention to the other agricultural products demanded by the home market, we may expect the development of other agricultural industries to such an extent as to be able to supply the home market, and make the income from coffee so much clear money for the people.



HAULING DRIED COFFEE (IN THE BERRY) TO THE WAREHOUSE
“SANTA ADELAIDE” FAZENDA, NEAR RIBEIRÃO PRETO.



II. MINING.

Aside from the gift of a fertile soil, nature rewards the people of S. Paulo for digging beneath the surface. The mining industry has not yet received a great deal of attention, though it is known that a number of useful minerals lie imbedded beneath the soil. In mineral wealth S. Paulo ranks next to Minas Geraes among the states of Brazil.

Iron

Deposits of pure magnetite are found in certain localities, the best known of which being at Ypanema, near Sorocaba. Two smelting furnaces have long existed there. The ore in that vicinity contains about 68 % of iron. Other similar deposits are found on an affluent of the Iguape River. It is believed that large quantities of this the most useful of minerals will some day be discovered in this state.

Precious Metals and Gems

One of the three ranges of hills in Brazil which contain auriferous beds extends into S. Paulo. This range is called the Mantiqueira. The ore is found also in other localities, resting on granite and mica schist, — ore which yields an ounce of gold to about 14 cubic yards, according to the estimate of Dr. Gorceix. Gold and silver both were mined near Sorocaba two centuries ago. Diamonds are found in the vicinity of Rio Claro.

Manganese, Lead, Aluminium, Coal.

Manganese exists at Perús, not far from the city of S. Paulo, and more than 3,300 tons of it have already been used in the industries of this city. Lead is found at Iporanga and Apiah. An excellent sample of aluminium found in the clay near Batataes was exhibited at a local fair held last year at Ribeirão Preto. Carboniferous beds have been discovered

near Tatuhy by Dr. Gorceix. There are indications of the existence of coal in other localities but the subject has not yet been sufficiently investigated. If fuel can be found in large quantities, it will mean the immediate development of the iron industry, from which much is expected in S. Paulo.

Marble and Granite

Marble of various colors is quarried in large quantities in this state. This industry has assumed most importance in the district of Sorocaba, where the marble is polished and prepared for the market. Granite quarries in different localities supply considerable quantities of granite of excellent quality for building and paving.

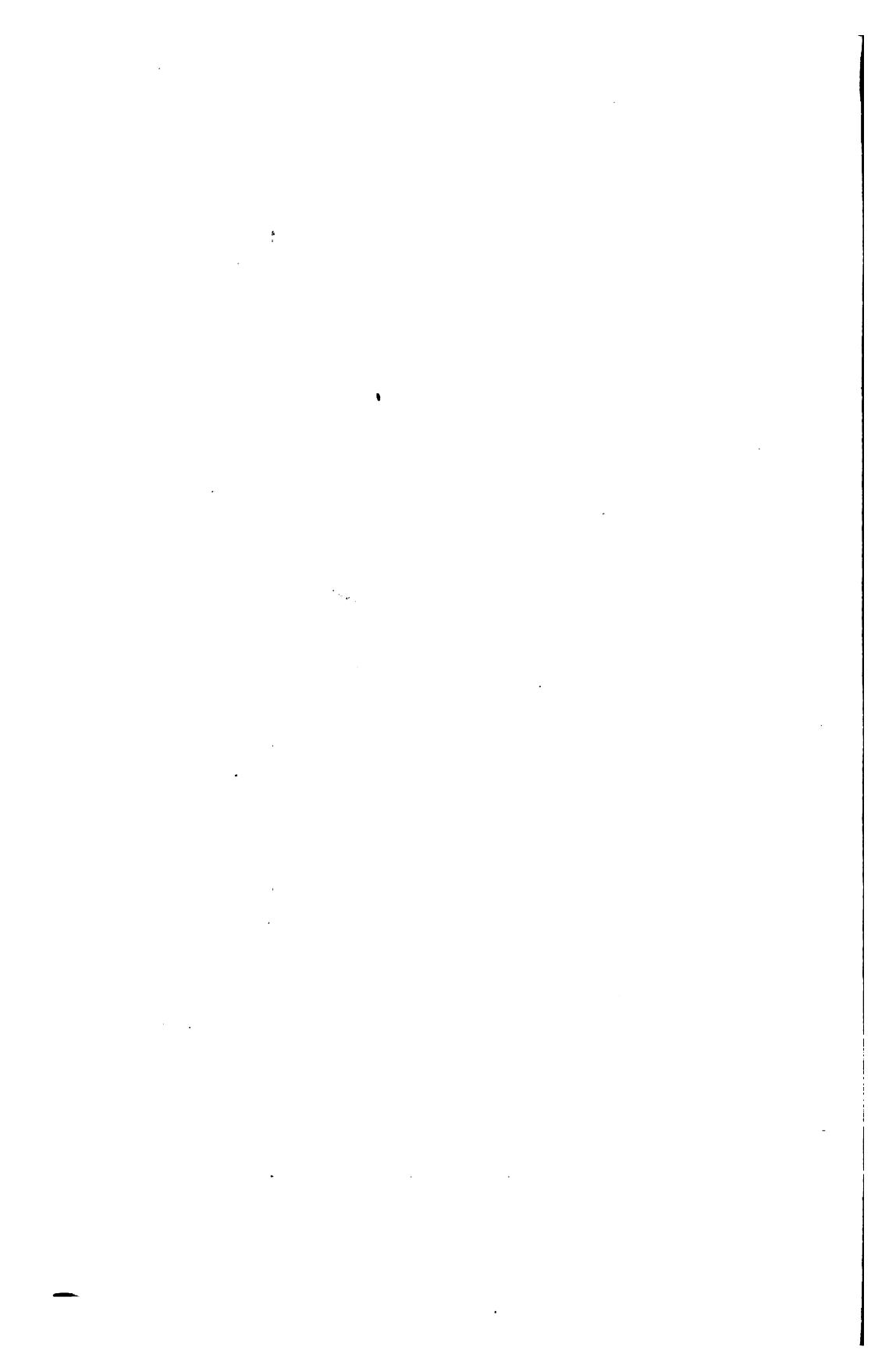
Since the discovery of this continent, explorers and settlers have always sought the precious metals and gems lying on or near the surface, so that more useful metals have been neglected. There is evidence that, when attention is directed to the latter, the results may be of far greater importance than all the discoveries of diamonds and gold in S. Paulo during the centuries gone by.

III. MANUFACTURING.

The people of this state do not undertake to manufacture for foreign markets, the object of this branch of industry being merely to supply the home market. Consequently it is the ordinary necessities of life that have received most attention thus far; while coffee is supposed to furnish the money to buy the luxuries which the people may desire to import from abroad. Most kinds of manufactured articles needed by the people are made in smaller or larger quantities in S. Paulo; so that the manufacturing industry has



MACHINES FOR CLEARING COFFEE. — THE "AUGUSTO" MACHINE FOR DRYING COFFEE.
"SANTA ADELAIDE" FAZENDA, NEAR RIBEIRÃO PRETO.



made a start, and now merely needs to be developed. Some of the factories use exclusively native raw materials, so that the growing and preparation of these materials constitutes important industries already mentioned above, under agriculture or mining. Other kinds of factories are dependent in part or entirely on imported materials.

1. Foods and Stimulants.

Flour and Meal

In the principal towns and cities of the state are found various establishments which make articles of food. There are a number of flour mills which are well equipped and make excellent flour. The largest and most modern of these is the Mattarazzo, located in the state Capital. This large mill utilizes more than 500 horse-power, and turns out 750,000 barrels of flour annually. Originally, it was operated by means of steam. Recently, however, electricity has been substituted, and two motors of 300 horse-power each do the work. The electricity is furnished by the S. Paulo Tramway, Light, and Power Co. which has its power house at Parnahyba on the Tieté River, 21 miles distant from the mill. All the wheat used is imported from the La Plata countries. It is estimated that 1,500,000 barrels of flour are consumed annually in this state.

Flour is made also from rice in various localities, the machinery being the same as for the manufacture of rice flour in the United States.

Corn mills are very numerous in both city and country. One is found on nearly all coffee fazendas, in some cases run by water power, in others by steam, in still others by animals. These mills have generally displaced the old-time monjolo (a primitive pounding mill operated by water power, said to have been first discovered in use among African savages by the Portuguese in the 15th century, and later introduced into Brazil). Altogether there are fully 10,000 mills

in the state, small and large, for the grinding of wheat, rice, and corn.

Bread, Macaroni, etc.

Every city, town, and village of the state has its bakeries which do their work more or less satisfactorily. The manufacture of macaroni and vermicelli constitutes an important industry, especially among the large Italian population. At least 650,000 pounds of these two articles are made annually in the city of S. Paulo alone, the quality comparing favorably with that of the macaroni and vermicelli of Italy and other countries.

Fecula

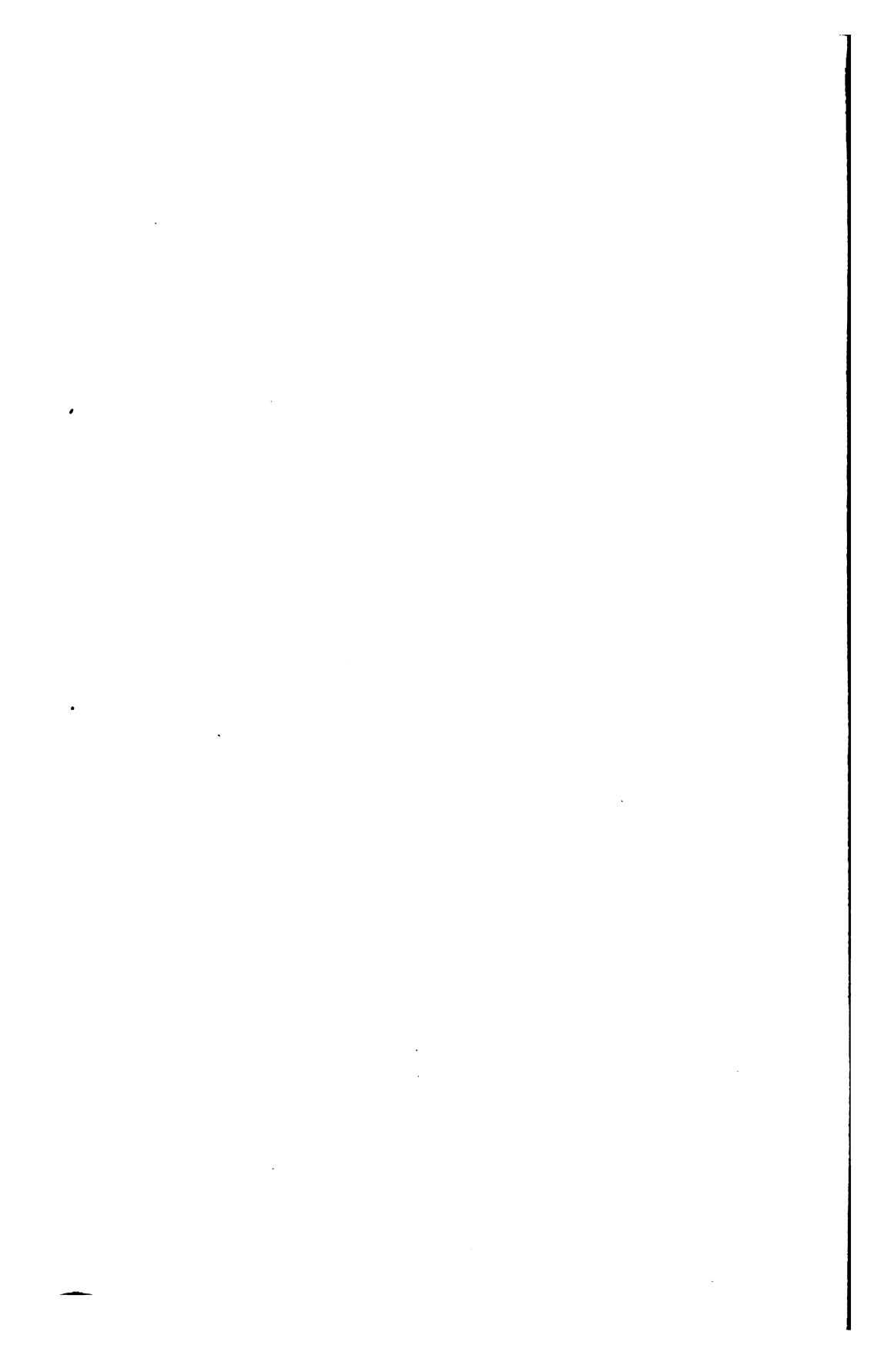
This section of Brazil is the home of manioc, of which there are more than thirty varieties. It is on the market in various forms, the best known of which in the United States is tapioca. The factory breaks down the texture of the manioc by scraping, and then separates it. The manioc is then put into water, and after being decanted the sediment is dried and pulverized. Besides tapioca, a very generally used article made from manioc is the flour, called *farinha* by the Brazilians. One of the best known factories is the *Jacinto Braga Moreira* of Ribeirão Preto, the products of which generally win the prizes offered at local fairs. At Mogy das Cruzes, P. Kuch & Co. makes fecula from potatoes, yams, and St. Thomas bananas. As much as 6,600 pounds of tapioca may be obtained from an acre of ground without the use of fertilizer.

Canned Goods and Confectionery

Some attempts have been made to can meats and fruits, but this industry has not been extensively developed. The oldest establishment of this kind is that of Zimmerman. Chocolates, caramels, and other confections are made in other



HAULING COFFEE TO THE RAILROAD STATION.
“SANTA ADELAIDE” FAZENDA, NEAR RIBEIRÃO PRETO.



cities, The best known candy establishment in S. Paulo is that of Christoffel Stupakoff, where modern machinery is in use.

Oils

Oils like the sesame, the peanut, the castor are used for food; while others such as cotton-seed and mineral oils are used for industrial purposes. The principal castor oil factory is at Ribeirão Preto, its daily output being 600 pounds. Professor A. C. da Silva Telles, (mentioned above in connection with aramina) has extracted from the seed of a plant called Paineira (*Bombax heptaphilum*) an oil excellent for both food and industrial purposes. The seed yield 25 per cent of oil. Five and a quarter million gallons of cotton seed oil are made in this state. Oil is produced also from schist found along the Parahyba River, the factory being at Taubaté.

Beer

The making of beer constitutes one of the most flourishing industries in S. Paulo. About 14 years ago the first brewery in the state Capital was erected at the instigation of Dr. Luiz Barreto, and based on the principles of Pasteur. This brewery is operated to-day under the name "Companhia Antarctica Paulista". A little later H. Stupakoff & Co. established the "Bavaria". Each of these two breweries has its own ice factory. The annual production of the two amounts to about 1,600,000 gallons of beer and 40,000 tons of ice. In flavor and beauty the *Antarctica* and the *Bavaria* rival the German beers. About 4,400 tons of barley and 55 tons of hops are used annually. The companies employ some 300 horses and mules.

There are also numerous smaller breweries which make use of other ingredients than barley and hops, — breweries which have a yearly output of some 2,600,000 gallons. The bottles used are made in S. Paulo. More than \$ 6,000,000

is invested in the beer industry, furnishing employment to 2000 laborers.

Tobacco

The soil and climate of S. Paulo make it possible to grow a good quality of tobacco; still the raw material used by most of the factories comes from Minas Geraes, Bahia and Rio Grande do Sul. In the state Capital there are six important factories, the largest of which belongs to Cardoso de Andrade & Co. Their annual output has a value of nearly \$ 2,000,000. In Campinas the factory of Tito Martins Ferreira makes cigarettes also. The annual production of this factory is estimated at 400,000 pounds. Besides these there are a considerable number of smaller factories in the several cities of the state.

2. Textile Fabrics.

Jute, Flax, Hemp

The coffee industry has created an enormous demand for bags in which to ship the coffee, and sheets needed in picking. This demand has given rise to factories for weaving jute. The largest of these factories is in the city of S. Paulo, and belongs to Snr. Alvares Penteado, the number of looms being 600. Snr. H. Maggi has erected a factory at Barra Funda, with a capital of \$ 375,000, for making articles from jute, flax, and hemp. It is capable of turning out 880,000 pounds of rope, cord, etc. a year. The annual output of the several factories of the state amounts to some 13,200,000 pounds. The capital invested is about \$ 2,000,000, and 1,100 horse-power is employed.

Aramina

On June 4, 1903, a factory was put into operation for the spinning and weaving of the new textile fibre known as



“GUATAPARA” FAZENDA
TRANSPORTING COFFEE BY WATER



aramina. This factory has a capital of \$ 125,000 and is under the management of the creator of the industry, Prof. Silva Telles. It spins about 4,400 pounds of yarn a day, and its 60 looms can weave annually a million and a half coffee bags. The factory is making a variety of articles from aramina, among which we may mention bagging, ropes, all kinds of canvas, carpets, trimmings, curtains, etc. In appearance and durability aramina products surpass those of jute.

Cotton and Wool

The first cotton factory erected in S. Paulo, called the "S. Luiz", is located at Ytú. It dates from December, 1869, and is still the most important in the state. Its erection was due to the initiative of Coronel Luiz Antonio de Anhaia, aided by the Barão de Piracicaba and others. It turns out annually about 3,960,000 yards of cloth.

There are to-day 18 cotton factories and 1 wool factory, with which must be reckoned 3 that work both cotton and wool. These 22 establishments have about 4,500 looms in operation making cloth of all grades. Some of the products are sent to other states, though the larger part is consumed in S. Paulo. Some of these factories use cotton raised in the immediate vicinity, as is the case at Tatuhy; while the districts of Capivary and Sorocaba furnish cotton for various factories. Some of the raw material is brought from northern Brazil, principally from the state of Pernambuco. The wool used in S. Paulo comes from abroad. Some of the factories are lighted by electricity and are operated at night.

The annual consumption of cotton products per capita is relatively small, less than 11 pounds, whereas in North America the consumption is more than twice this amount.

The capital invested in cotton and wool factories amounts to some \$6,125,000; the annual output is 40,000,000 yards of cloth, valued at \$5,000,000. Water power is employed by some of these factories, steam by others.

In some cases the yarn is dyed before being woven; in others the white cloth is sent to a bleaching establishment where it is bleached and stamped. The largest of these establishments is at Sorocaba and belongs to the Banco União of S. Paulo, capable of bleaching a fourth part of all the cloth made in the state. Its work is of an excellent quality, and its products are on the market in all the states of Brazil.

3. Paper, Printing, etc.

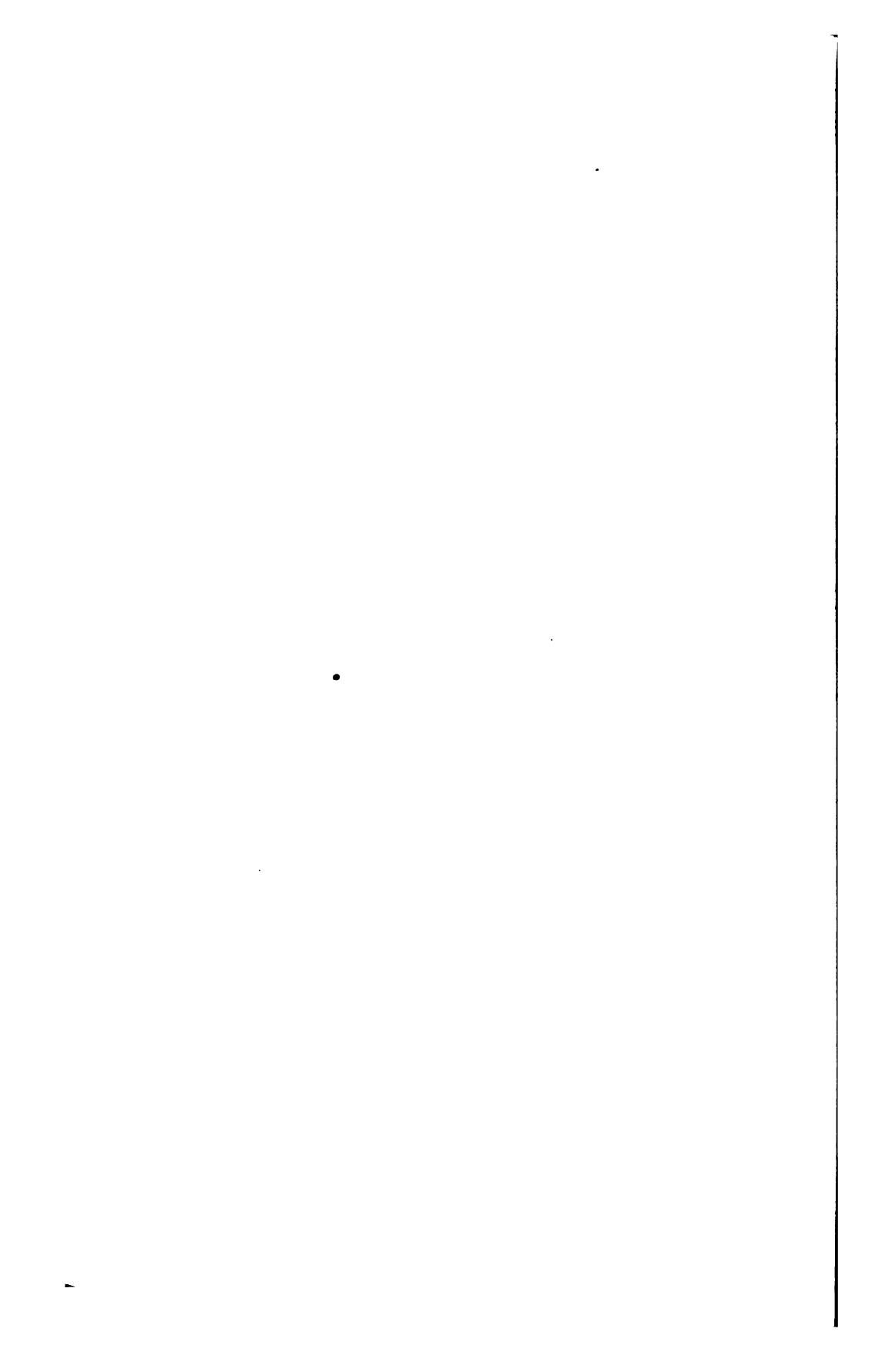
Paper

The first paper factories in the state were that of Melchert at Salto de Ytú, erected in 1889, and the one at Cayeiras, erected in 1890, now the property of the „Companhia Melhoramentos de S. Paulo“. The problem of obtaining raw materials was studied, before the latter was put up, by the writer, then engineer-in-chief for the company at Cayeiras. Several native plants and woods were tried. A superior quality of paper was made from them, but at too great cost so that the product could not compete with the paper made abroad. The high cost price was due largely to the cost of chemicals required in the manufacture. Guaraná yields 12 % of fibre, paper made from which costs 15 cents a pound. The banana tree yields 10 % of fibre, and the brown paper made from it costs $5\frac{1}{2}$ cents a pound. Paper made from Samambaia furnishing 13 % of fibre costs 6 cents. Sapé gives the best results. The fibre amounts to 21 %, and the paper costs 5 cents a pound. At the same time the rag industry had developed to such an extent as to furnish yearly 400 tons of raw materials at about 1 cent a pound. Rags and imported wood pulp will continue to be used for making paper until the price of chemicals is reduced and native raw material furnished in larger quantities at lower cost.

The two factories mentioned are run by water power, and turn out some 2.200,000 pounds a year, valued at \$ 125,000, the capital invested being \$ 600,000.



TANKS — LABORERS.
“GUATAPARÁ” FAZENDA.



Printing etc.

Printing presses are in operation in nearly all the towns and cities of the state, the city of S. Paulo being the most important center of this industry. Here the largest number of daily papers and books are printed and job printing is done on a large scale. One of the oldest printing houses and stationary dealers is Duprat & Co., in existence since 1850. Some of these houses also do excellent work in lithography and various kinds of engraving. About \$2,000,000 is invested in this industry.

4. Clothing.

Hats

In the state Capital there are six factories making men's hats, the largest of which belongs to Manzini, Schiffini & C., the annual capacity of this one being 200,000 hats. The oldest of the factories in this city are those of J. A. Schritz-mayer and Abilio Soares. In Campinas the largest is that of Kaysel & Scheiner, with a capacity of 36,000 hats. The larger part of the products of these factories is consumed in this state, though the shipment to other states is considerable. The capital invested is something over \$610,000.

Tailoring, etc.

Various tailoring and millinery establishments are found in the several towns and cities of the state, the most important of them being in the city of S. Paulo.

Leather

The largest tannery is that of Marx & Co., which makes leather not only for shoes, but also for harness, belting, etc. It can tan 30,000 hides a year. Next in order of importance is the tannery of Senhor Penteado in Campinas, with a capacity of 10,000. The hides of both domestic and various wild

animals are used. The tannin required is obtained from a large variety of Brazilian plants. The capital invested in the tanning business amounts to upwards of \$ 750,000.

Shoes and Gloves

The shoe factories of the state use both native and foreign material, and their products are on the market along with foreign made shoes. The Mellilo factory is among the largest, and uses the most improved machinery, Rocha & Co. also makes good shoes.

The products of the several glove factories are all consumed in the state and are much in demand. The shoe and the glove industries have a capital of about half a million dollars.

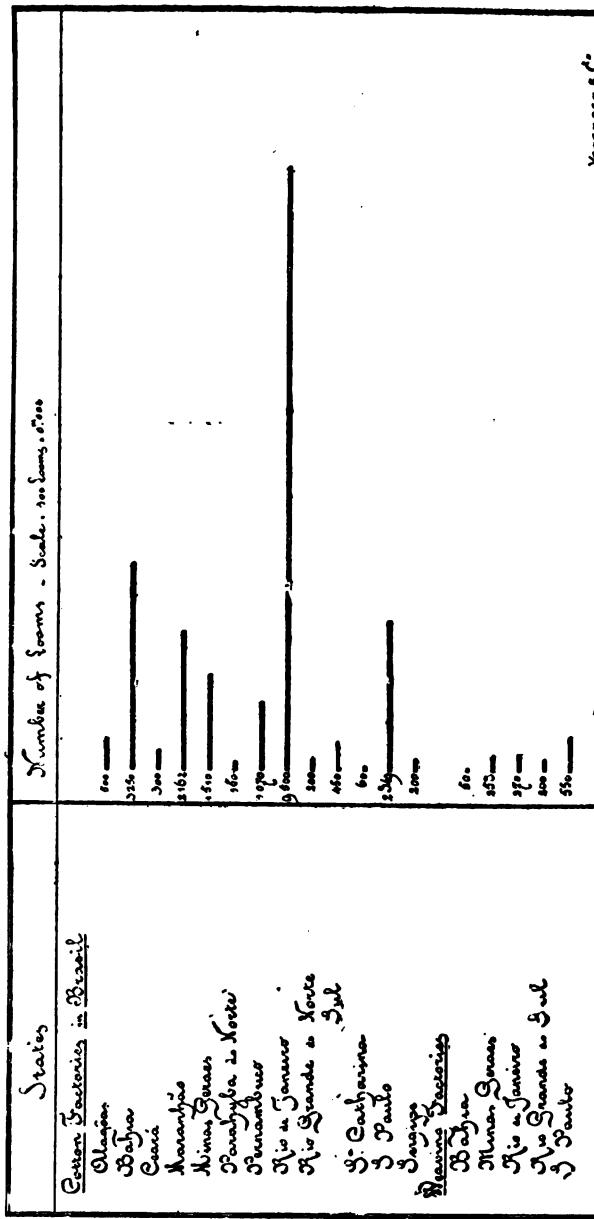
5. Building Materials and Furniture.

Lumber

The forests of S. Paulo contain a variety of trees suitable for lumber, nearly all being hardwood. This lumber generally takes a very high polish and is adapted to the finer grades of furniture as well as to the construction of houses. Almost all coffee fazendas and railroad stations have their saw mills, generally a circular and a vertical saw; while large saw mills and planing machines are found in the principal cities of the state, especially the Capital. Something over a million and a half dollars is invested in this industry.

Lime

About 10,000 tons of lime are produced annually by the several kilns, of which the largest are at Cayeiras and Itaporaranga. There are kilns also at Sorocaba, Perús, and other points. Limestone is abundant, and most of these kilns have railroads and plenty of rolling stock for conveying



Firms	Country	Number of Sums. Bank. no. 8.000
C. Fabril Paulista Industrial de São Paulo	S. Paulo	100
S. J. & S. J. S. J. & S. J. S. J. & S. J.	S. Paulo	100
S. J. & S. J. S. J. & S. J. S. J. & S. J.	S. Paulo	100
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S. J. & S. J. S. J. & S. J. S. J. & S. J.	S. Paulo	100

SANTO S
1000000 BACS

COFFEE EXPORTATION

FOR THE CROP YEAR 1901 - 1902

RIO
5696000 BACS
IN BAGS OF 60 KILOGRAMS

EVERY BAG REPRESENTS 50000 BACS

BAHIA
AND
VICTORIA
750000 BACS

COLUMBIA
AND
CENT-AMERICA
1150000 BACS

OTHER
VENEZUELA COUNTRIES
800000 BACS

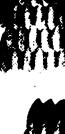
JAVA
517000 BACS

HAYTI
450000 BACS

425000 BACS

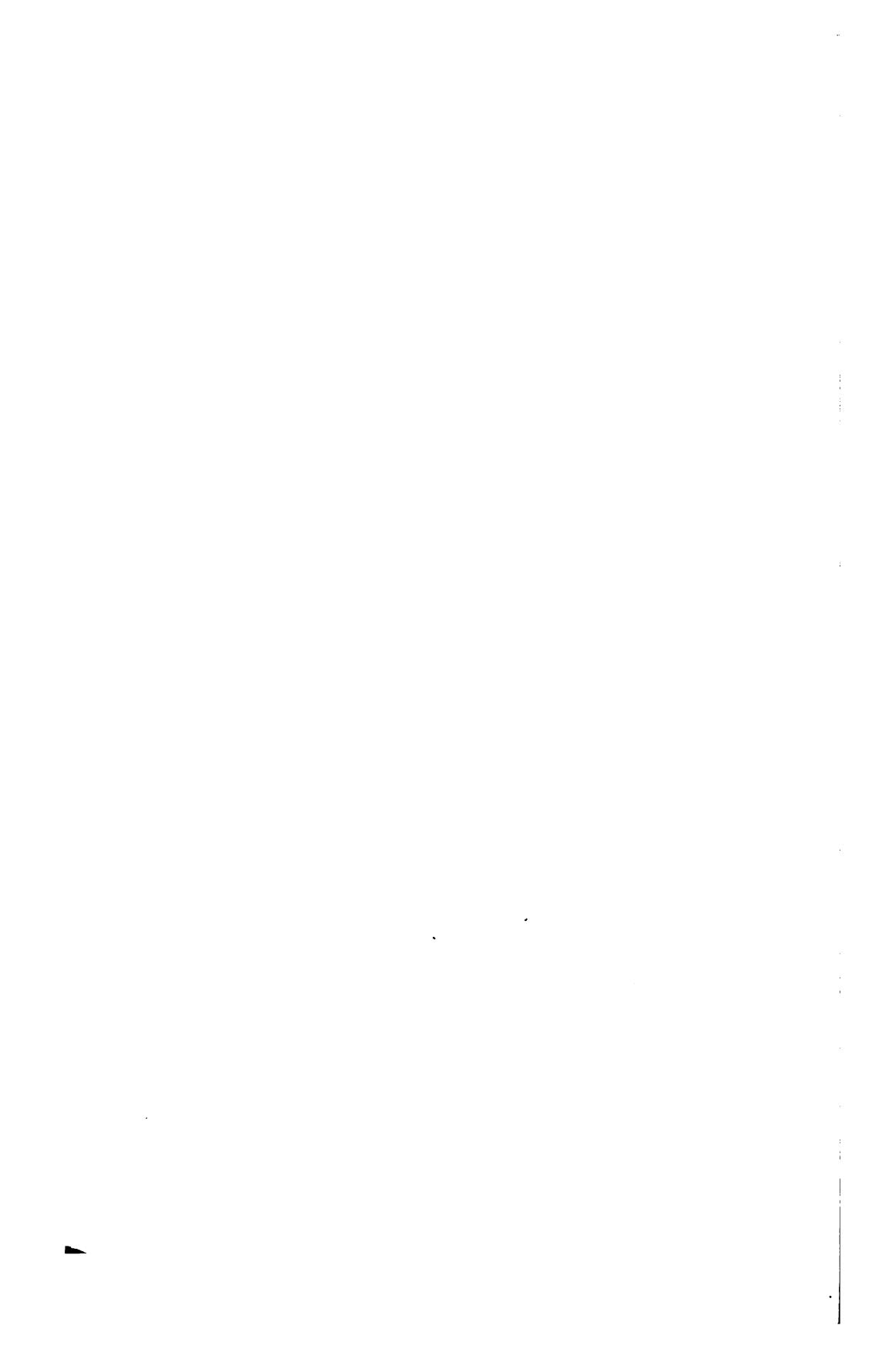


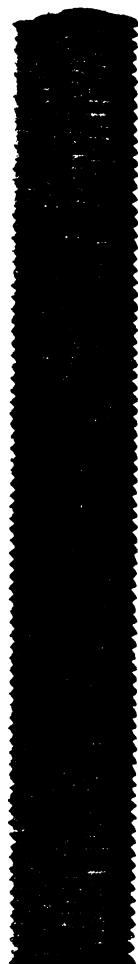






BRAZIL FOREIGN COUNTRIES





COFFEE EXPORTATION
FOR

THE CROP YEAR 1901-1902.

IN BACS OF 60 KILOCRAMS

EVERY BAC REPRESENTS 50000 BACS



BRAZIL
16246.000 BACS.

FOREIGN COUNTRIES
3342000 BACS.



it to the place where desired. The capital invested is about \$ 750,000.

Cement

The largest cement factory in South America is at Piragibú, erected at the instigation of Col. Antonio Rodovalho. It uses material found in the vicinity, employs 450 horse-power, and turns out annually 15,000 tons of cement.

Furniture

The city of S. Paulo is the center of the furniture industry, the most important establishment being the "Santa Maria", which makes a great variety of furniture. Articles made by the Lyceu de Artes e Officios are also of a high class. There are 10 factories in this city and others in the several cities of the states. Their capital amounts to about half a million dollars.

5. Foundries, Machine Shops, etc.

Machinery, Tools, etc.

The coffee business has given rise to a number of other industries, among which one of the most important is that of manufacturing the machinery, tools, implements, etc. needed on a fazenda. In the state Capital the Companhia Mechanica e Importadora, the Lidgerwood, the Arens Brothers, and the Mac-Hardy Co. all manufacture machines for hulling and sorting coffee, and even build steam engines. These and other companies work in both iron and brass, as well as wood, their products being equal to those imported from abroad. Machine shops and foundries exist in most of the important towns and cities of the state. The railroad companies all have their shops which make rolling stock and other railroad equipment.

Nails and Shot

A nail factory is in operation in the city of S. Paulo, belonging to Stoltz & Co. There are several factories for making shot and lead pipes.

The capital invested in these several industries exceeds 4 million dollars, and employment is given to 2,500 laborers.

7. Various Manufactures.

In addition to the manufacturing industries already mentioned, a large number of articles of the most varied character are made on a larger or smaller scale in S. Paulo.

Pottery

Possibly the most important of these manufactures is that of pottery of various kinds. Clay and kaolin abound for making tiles and bricks; also the necessary elements to mix with them are found almost everywhere. Terra cotta piping and ordinary earthen ware are made in large quantities. Among the most important manufacturers of pottery we may mention the Companhia Melhoramentos at Cayeiras, and Falchi Brothers, Cresto & Co., S. S. Lavand & Co. More than a million dollars is invested in this branch of industry.

Glass

The largest glass factory in the state is the "Santo Marina", located at Agua Branca, erected by Messrs. Antonio Prado and Elias Fausto Jordão. (¹) It turns out more than 3,000,000 bottles annually. All the materials except sulphate of sodium are found in the vicinity. The Cristallaria Germania and other factories make nearly all kinds of glass-ware demanded by the home market. Something over a quarter

(¹) To-day this factory belongs to a Company.



THE SÃO PAULO TRAMWAY, LIGHT & POWER CO. LTD.
GREAT DAM AT PARNAÍBA.



ter of a million dollars is invested in the glass industry, and the annual output is valued at \$ 200,000.

Matches

About \$ 200,000 is invested in a match factory located in the suburbs of the state Capital, this being the only factory in the state. Most of the raw materials required, are imported, except the wood, which comes from the State of Paraná.

Powder

The oldest of the powder factories is at Perús, established in 1884, and belonging to Dias & Sons. The largest is the „Jupiter Factory“ at Saboima, belonging to F. Braga & Co., Both have modern machinery operated by hydraulic motors. The products of these factories are extensively used for both firearms and quarrying.

Chemicals and Medicines

Sulphide of carbon, sulphuric and other acids, and various medicines are manufactured in S. Paulo to some extent. Brazilian plants, rich in medicinal properties, offer a large field for investigation and development.

Miscellanies

The making of jewelry, brushes, perfumeries, soap, and various toilette articles involves the investment of large capital, and a great number of laborers find employment.

IV. VARIOUS INDUSTRIES

A number of industries exist in S. Paulo in which tens of millions of dollars are invested —, industries which can be classed under neither agriculture, mining, nor manufacturing. We may mention here the railroad business, the illumination of cities, and the industries connected with electricity.

1. Railroads

The greatest of the industries to which the coffee business has given rise is the railroad. Thirty years ago there were only 155 miles in operation in the state; to-day there are 2455 miles. The five principal companies are "The São Paulo Railway" (the only line starting at Santos), the "Paulista", the "Mogyana", the "Sorocabana and Ytuana", and "Central of Brazil" of which the last four are native companies. Besides their lines there are a large number of short roads, for the most part feeders of the trunk lines of the five companies. As the most important of the smaller companies and the one having the greatest future, we may mention the "Araraquara", whose line is far in the interior of the state. This company has obtained state and federal concessions for extending its line to S. João do Rio Preto, located beyond the termini of other roads; and thence by way of the great cataracts at the junction of the Tieté and the Paraná, on into the vast state of Matto Grosso.

The capital invested in railroads in S. Paulo is about \$ 75,000,000, and the annual gross receipts \$ 14,000,000. For a full account of this branch of industry the reader is referred to the "History of Railroads in the State of S. Paulo", prepared by Clodomiro Pereira da Silva, or the one by Adolpho Pinto (Engineers).

2. Illumination of Cities.

The primitive custom of lighting up streets and houses by means of candles and lamps burning animal and vegetable



THE SÃO PAULO TRAMWAY, LIGHT & POWER CO., LTD.
INTERIOR OF POWER HOUSE — PARNAÍBA



oil has almost passed away and has given place to the more modern practice of illuminating by means of petroleum, acetylene, gas, and electricity. Streets, churches, theatres, factories, and private residences are now dependent for light upon these comparatively recent discoveries and inventions.

a) *Petroleum and Acetylene.* About 85 towns of São Paulo use petroleum for street illumination, while 2 have adopted acetylene. Also thousands of fazendas and scores of factories in different parts of the state make use of these two sources of light. Water power and raw materials for the manufacture of carbide of calcium are abundant and point to a far larger use of acetylene for illumination purposes. Carbide of calcium can be made here at a cost of $4\frac{1}{2}$ cents a pound, whereas the imported article costs $6\frac{3}{4}$ cents. About a quarter of a million dollars is invested in equipments for the illumination of streets and buildings by means of petroleum and acetylene.

b) *Gas.* There are 4 cities which have plants for making gas for illumination and domestic purposes. These four are S. Paulo, Campinas, Santos and Taubaté. The largest of the plants is the one in the first-named city, operated by the "S. Paulo Gas Company. Ltd." In the year 1900 it made $58\frac{1}{4}$ million cubic yards of gas, worth \$331,000. The by-products were 248,000 cubic yards of coke, worth \$96,000, and 6,227 barrels of tar, worth \$13,000. The value of the several products of this plant thus amounts to some \$440,000. About 15,750 tons of coal were used; also 1,268 tons of ferric oxide and 277 tons of lime. The burners used for public lighting number 3,483, the length of pipes being 105 miles.

The four gas plants of the state represent capital exceeding \$ 1,000,000.

c) *Electricity.* There are 20 towns and cities in S. Paulo that are lighted by electricity. The first plant was installed 13 years ago, though more than half the plants are the work

of the last four years. They represent a capital of some... \$ 3,000,000. In some cases steam is the motive power. The hydraulic motors are generally turbines with horizontal shafts.

The position of the turbine shaft and the suppression of gearing contribute to make the plant at Amparo one of the most interesting in the state. Beside three vertical-shaft turbines requiring altogether 6,478 gallons of water, a new one was installed in 1902, requiring 8,200 gallons with a 24 foot head. A Brown Boveri alternator of simple monophase current of 147 kilowatts is mounted on the vertical shaft of the turbine. The power-house is $3\frac{3}{4}$ miles from the center of the town, on the picturesque Camandocaia River. The current is transmitted on wires having a cross-section of 7 square millimeters (no. 9, Brown & Sharpe), with a loss of 8 per cent. The city has 50 arc lights of 10 amperes each.

At Rio Claro the power-house is 5 miles from the city on the Corumbatahy River, having a hydraulic motor of 900 horse-power. The distribution is made in a three-phase current of 50 cycles at a pressure of 110 volts.

The alternators (Siemens & Halske) generate a current of 4,200 volts, carried on wires elevated 25 feet above the surface. The city is lighted by 50 arc lights of 12 amperes each, distributed in series of 3 lamps. The incandescent lights vary in candle power from 5 to 32.

The Ribeirão Preto plant is one of the most successful in the state from an economic standpoint. Water power for operating it was secured by constructing a dam across the river near by. The distribution is made with a three-phase current of 2,000 volts generated by Siemens alternators (50 cycles). The public squares of the city are illuminated by arc lights, the streets and houses by incandescent. The candle-power of the latter varies from 16 to 32 for the streets, and from 8 to 16 for houses.

In other cities which have electric plants (Casa Branca, Jacarehy, Cravinhos, Sorocaba, etc), the streets are usually illuminated by incandescent lights, while arc lights in private



FALLS OF THE PANTANO.





THE FALLS AT PIRACICABA
ON THE RIVER OF THE SAME NAME.



buildings are very rare. The voltage over transmission lines varies from 1,000 (at Jacarehy) to 5,800 (in Amparo), being in excess of this only in the city of S. Paulo. The strength of the current seldom exceeds 2 amperes to the square millimeter on the transmission lines; while on the distribution lines it averages 1 ampere to the square millimeter. The two or the three wire systems of distribution (Edison) are the ones generally in vogue. The first transformers were either of the parafin bath type, or of the fan-cooled. The insulators also vary, depending on their location and the tension of the current. They are usually made of porcelain, while the conductors and connections are of copper.

The cost at which electric lights are furnished varies in different cities. For public illumination Piracicaba pays a lower rate than any other city, namely, .019 cent per candle-hour. S. Carlos do Pinhal pays .042 cent, which is the highest rate recorded.

The problem of furnishing electric power for industrial purposes has received serious attention, and in the cities of Ribeirão Pretó, Rio Claro and S. Paulo electricity is driving machinery in factories, shops, and laboratories. It is in the last named city, however, that the most varied applications of electricity are made; and we may conclude this survey of the industries of the state by giving some account of the electric plant in the city of S. Paulo —, this being the greatest plant of the kind in South America.

The S. Paulo Tramway, Light and Power Co., Ltd.

This company, having a capital of \$ 7,000,000, was organized in Toronto, Canada, with Mr. William Mackenzie as president. Its formal authorization for operating in Brazil dates from July 17, 1899, although preliminary work had been begun as early as May of that year. The object of

the company, as indicated by the name, is to operate a street-car system in a city numbering 300,000 inhabitants, provide for the illumination of streets, residences, etc., and to furnish power for all kinds of industrial establishments.

1. Companies Absorbed

When this company came on the scene, the field was occupied by three smaller companies. The first of them was the „Companhia Viação Paulista“, which was operating mule cars on 57 miles of track. There were in use 157 passenger cars with a seating capacity of 23 each, 26 freight cars, and 2,300 mules, with the necessary shops and stables. The second of the three companies was operating a steam tramway from S. Paulo to the village of Santo Amaro 12 miles distant. The third was the „Companhia Água e Luz“, an electric company which supplied some 5,000 incandescent and 100 arc lights. All three of these were eventually absorbed by the S. Paulo Tramway, Light and Power Co., which now holds the field alone.

2. Temporary Steam Plant

This company planned to construct a great water power plant at a considerable distance from the city, for the completion of which fully two years would be required. As it was important that the company should commence operating street-car lines as soon as possible, it was decided to erect a temporary steam plant, which was accordingly completed before May 7, 1900, when the first electric cars were put into service. The installation of this plant consisted of 2 Robb-Armstrong engines of 350 horse-power each, directly connected to two 225 kilowatt generators (General Electric Company); also switchboard and feeder panels for the control and distribution of current, and the necessary heaters, pumps, injectors, etc. This plant furnished power for running 26 cars with a seating capacity of 45 each, and regular service was



FALLS OF THE TIETÉ RIVER
AT YTU.





FALLS OF THE ITUPARARANGA RIVER
AT SOROCABA.



maintained by this means until September, 1901, when the water power plant was completed and put into operation.

3. Water Power Plant

The water power most easily developed that is within transmission distance of S. Paulo, is 20.7 miles from the city, at the village of Parnahyba. There the Tieté River makes a descent of 38 feet in a distance of less than half a mile. The company made surveys and purchased the rapids and such lands as necessary for the construction of a great water plant at that point. The Tieté drains an area of some 2700 square miles before reaching Parnahyba, this area having an average annual rainfall of 65 inches. The lowest gauge of the river obtained shows a yield of 35 cubic feet of water per minute for every square mile of river basin.

a) Great Dam

In order to develop the power it was necessary to construct a dam across the river at the head of the rapids. This dam is 800 feet long, has an average height of 43 feet, and a width of 36 feet at the base and 12 at the crest. The dam rests on granite ledge, and is built entirely of granite quarried a few rods away. The masonry amounts to 23,000 cubic yards. The spillway in the middle is 462 feet long and permits the passage of 1,700,000 cubic feet of water a second, which is much in excess of the quantity of water during the greatest floods on record. The lake formed by the construction of the dam is some 5 miles long, and has an area of about 1 square mile.

b) Reservoir

At a distance of 2300 feet (down stream) from the dam, a reservoir was built near the power house by constructing a second dam, this time across a ravine. This dam, located on the left bank of the river, is 165 feet long and 50 feet

high. This reservoir, having a capacity of half a million cubic feet, was built in order to reduce the velocity of the water on the turbines.

c) Great Pipes

The water from the main dam is conducted to the reservoir by means of two enormous parallel pipes built into the dam 23 feet below the level of the spillway. These pipes are each 12 feet in diameter, made of riveted steel $\frac{3}{8}$ of an inch in thickness, perfectly straight in alignment, and level throughout their entire length. They are provided with 3 expansion joints necessitated by the 10 inch expansion which takes place with the variations of temperature. To support the pipes and the 7,500 tons of water constantly passing through each of them, steel saddles were built at intervals of 12 feet. The surface of the land over which the pipes run is irregular, necessitating excavations at certain points, and very high saddles at others. Whenever the pipes are less than 4 feet from the surface, they are supported by saddles resting directly on the masonry pedestals; when the distance is greater the saddles are provided with steel posts which rest on the masonry. The velocity of the water flowing through the pipes is normally about 3 feet a second. The water in the reservoir rises almost to the same level as the water above the main dam, giving a head of 75 feet at the power house.

d) Power House

The power house is located on the margin of the river at a distance of 178 feet from the foot of the reservoir. It was built on rock bed, with steel sills, tiled floor, granite pillars, brick walls, and French tile roofing. Its dimensions are 51 by 102 feet. In order to haul the materials for these several structures and the electrical machinery from the nearest railroad station, it was necessary for the company to build 8 miles of wagon road across very hilly country.

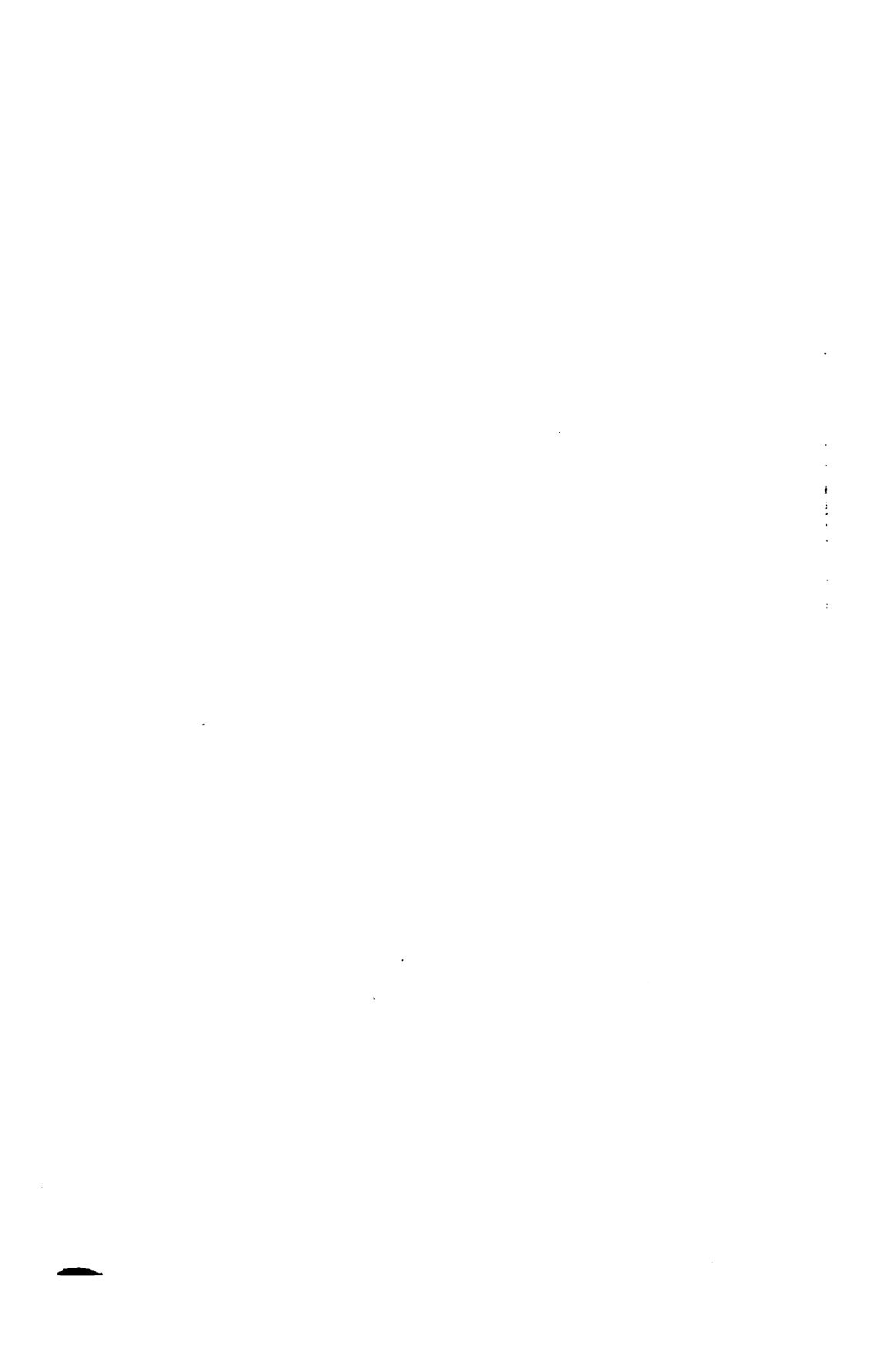


FALLS OF THE PARADOURO RIVER
AT CACONDE.





“SALTO GRANDE” (GREAT FALLS)
ON THE PARANÁPANEMA RIVER.



e) Turbines, Dynamos, etc.

The water is conducted from the reservoir to the turbines by means of 6 pipes, 4 of them being 8 feet in diameter, and the others 2 feet 8 in. Nipples were built into the reservoir dam for the installation of 4 additional pipes. The turbines were made in Dayton, Ohio. The larger ones are of the "Victor" type, duplex, horizontal, 48-in. gate, and making 200 revolutions a minute; they are designed to develop 2000 horse-power. The smaller ones making 550 revolutions a minute can develop 150 horse-power. All the electrical apparatus was made in Schenectady, New York, and consists of the following:

- a) Two 100-kw., 125 - volt excitors, directly connected to turbines, and making 600 revolutions per minute.
- b) Exciter switchboard, consisting of two panels for the excitors, and one feeder panel containing nine circuits.
- c) Four 1000 - kw., 2300 - volt, 60 - cycle, three - phase alternators of the revolving field type,
- d) Low - tension switchboard, containing three alternator panels, two station panels which record the output, and four three - phase transformer panels.
- e) Twelve 333 - kw. transformers wound for 2300 secondary and 24,000 primary, of the air-blast type.
- f) Three 70 - in. Buffalo blowers.
- g) High - tension switchboard, containing four transformer panels and four line panels, and has two sets of bus wires.
- h) Twelve 24,000 - volt lightning arresters.

The current is generated at 2,300 volts as a three-phase current, and is raised to 24,000 by 12 air-coaled step - up transformers, and is transmitted to the city at this pressure.

f) Transmission Line

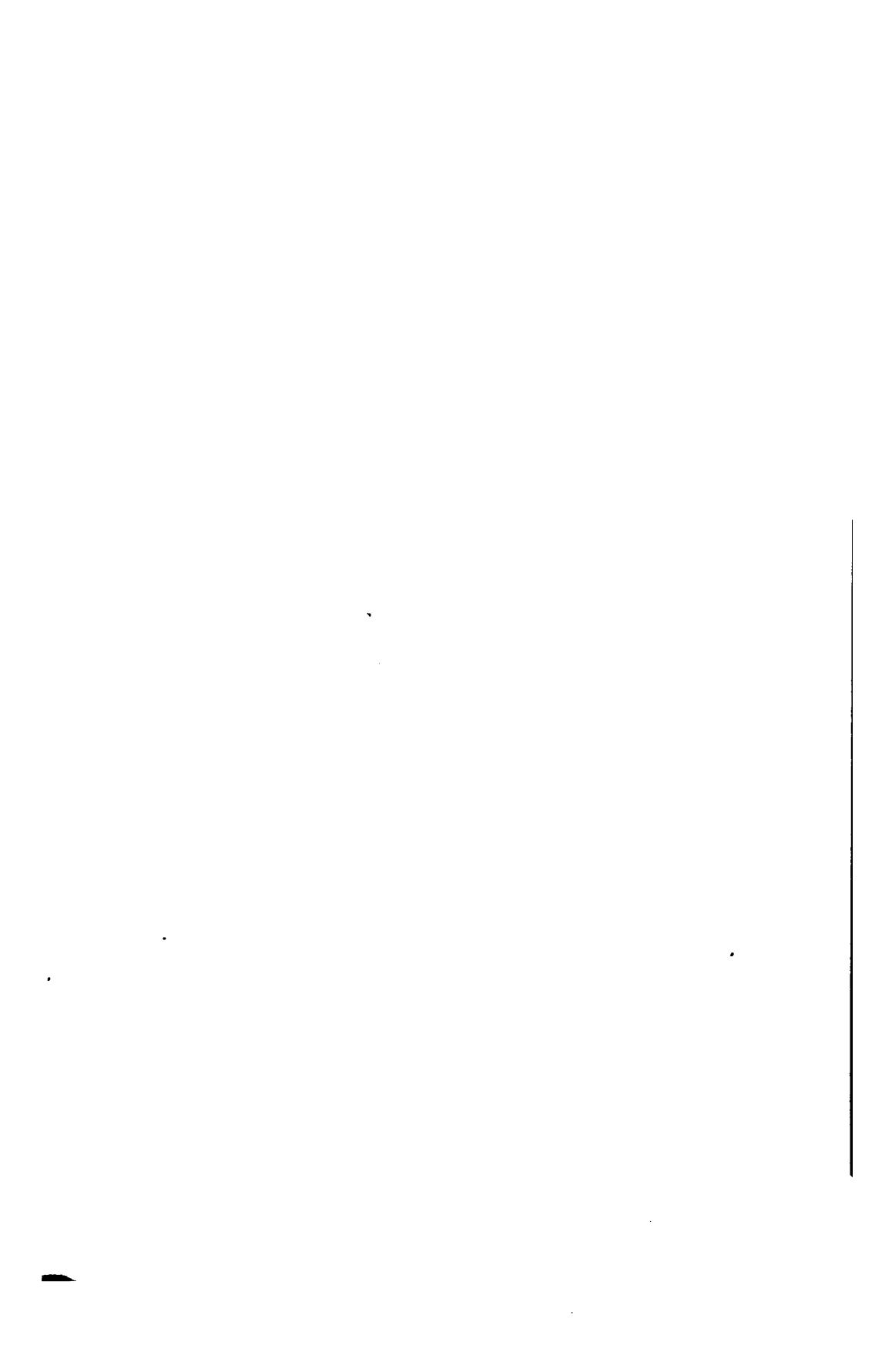
The company made a careful survey for its transmission line and purchased a strip of land 100 feet wide, extending from Parnahyba to the sub-station in S. Paulo. This strip is almost a straight line, though only 2 miles of it is over level country, the remainder of the distance being a succession of hills and valleys. There are two rows of poles $33\frac{1}{8}$ feet apart. In each row the poles, 28 feet in height, are at intervals of 110 feet, except on curves, grades and angles, where they are more frequent. The poles within the city limits are of Georgia pine, the rest being of native wood. Each of the rows carries two three-phase circuits, the conductors, arranged 30 inches apart, being No. 0 copper wire, supported on multipetticoat porcelain insulators. Three lightning arresters were put up at intervals along the transmission line to contribute to safety during storms. The loss of energy at full load between the power house and the sub-station is 7.9 per cent. The poles supporting the transmission lines carry a metallic circuit telephone line also, 5 feet lower down.

g) Sub-station

The sub-station is located near the center of the city, and is one of the most modern extant. It is built on piles driven through the river mud to sand bottom. The foundation is of concrete, the walls are of hard-burned, pressed brick, the framework is of steel, the roof and floor are of tiles, making a fire-proof structure. The transmission line runs along the margin of a small river to reach the station, having a safe and exclusive right of way. The high-voltage current is reduced through $1\frac{1}{2}$ air-cooled step-down transformers to a pressure of 2200 volts. At this pressure it is distributed to the 3 switchboards from which it is again distributed for the purposes of street railway, light, and power. The electrical apparatus of the substation consists of the following:



A WATERFALL ON THE FAZENDA
BELONGING TO SR. VIRGILIO DE FONSECA NOGUEIRA.





RAPIDS OF THE JAGUARY RIVER
AT FUNIL.



A RAPIDS ON THE MOÇY-GUASSÚ RIVER.





ITAPURA FALLS, ON THE TIETÉ RIVER,
NEAR THE JUNCTION WITH THE RIO GRANDE.

- a) Twelve 24,000 - volt lightning arresters.
- b) High-tension switchboard, containing four line panels and four transformer panels.
- c) Twelve 333 kw. transformers, wound for 20,000 volts primary and 2,200 volts secondary.
- d) Three 50 - in. Buffalo blowers.
- e) Low-tension and induction-motor switchboard.
- f) Four railway-motor generator sets with boosters.
- g) Direct-current railway switchboard, containing four generator panels and five feeder panels.
- h) Power-feeder switchboard, containing five 500 - kw. feeder panels for three-phase current at 2200 volts.
- i) Lighting switchboard, containing a totalizing panel to record the output for lighting service, and ten 200 kw. feeder panels.

h) Street Railway System

Street-car lines traverse all quarters of the city and run to the principal suburbs. The total length of lines is about 100 miles. All mule cars have been displaced, and some 95 electric cars, each with a seating capacity of 45, meet the requirements for rapid transit. The cars are furnished by J. E. Brill of Philadelphia, and the St. Louis Car Company. Only open summer cars are used, similar to those on Madison Avenue, New York. The fare is about 5 cents, except to distant suburbs, in which case one or two additional fares are paid. Special cars carry the mails between the post-office and railroad stations. All cars are lighted with electricity and have the usual equipment of the most modern type. On a level the cars may attain a velocity of 20 miles an hour. The rails on which they run are for the most part 92-lb. girder rails of the Metropolitan type; the remainder being 62-lb. T rails. They rest on steel ties laid in concrete, except on certain lines on which wooden ties were

adopted. The overhead construction is supported generally by steel poles, except where there are a number of light and power wires, in which case wooden poles are preferable.

j) Lighting System

Electric lights, either incandescent or arc, are available for every house and street in the city. The distribution of light is made in single-phase circuits, so arranged at the switchboard that any circuit can be thrown on to any phase, making it possible perfectly to balance the load on each phase. In the business portion of the city the distribution is by an underground, three-wire system, at 115 volts. The distribution to buildings is made through connections from the main underground feeders to an overhead system of sub-mains. In other parts of the city the overhead system is used, there the wires being supported by poles. The number of arc lights furnish by the company is 520, and the number of incandescent 29,000.

j) Power System

In the center of the city power distribution is underground, similar to that for lighting, with three-phase secondary, of 440 volts. The transformers are located in the same vaults with the lighting transformers. For the rest of the city the distribution is overhead on poles, the circuits being three-phase circuits of 2,200 volts. For small motors the voltage is reduced to meet requirements. The company has installed now 2,555 horse-power of electric motors. The largest single installation is that of 2 motors of 300 horse-power each for the Mattarazzo flour mills.

The total electric energy used at present is fairly shown by a recent month's average in kilowatt-hours as follows:

Street-car service .	571,118	K.W.H.
Power	452,728	"
Light	242,328	"

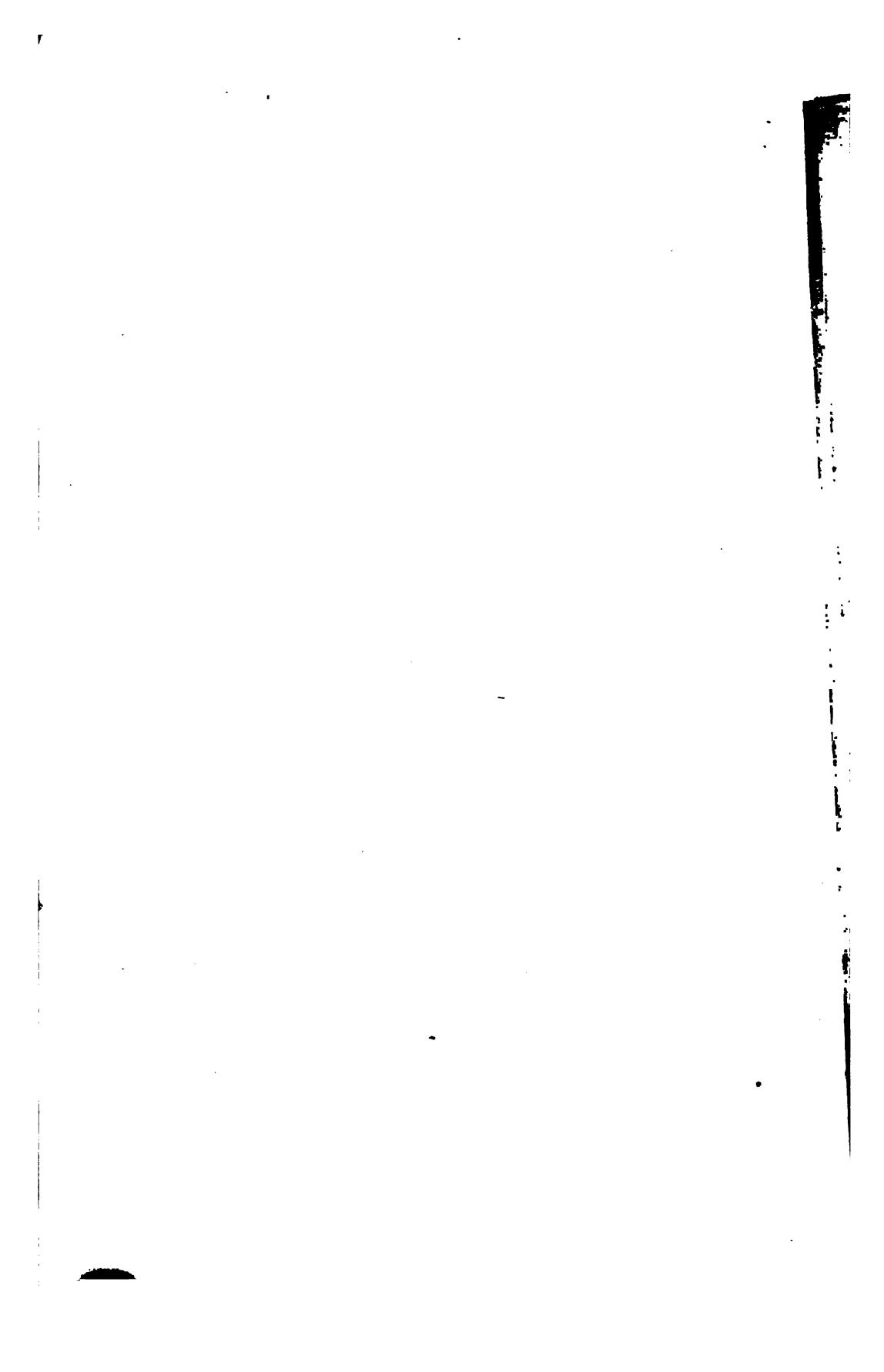
Water Power of the State

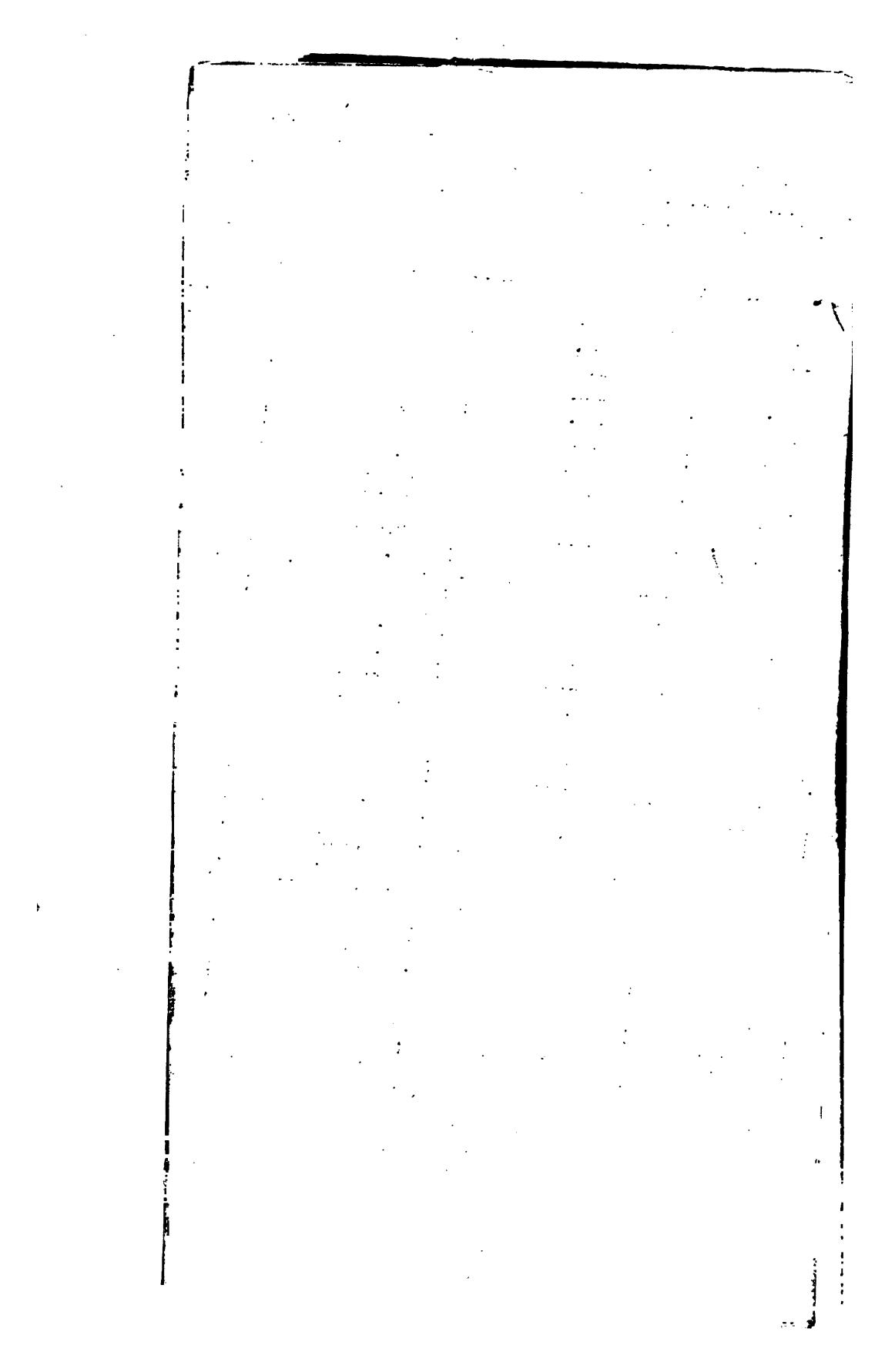
The success of the electric plants in S. Paulo and other cities has led to considerable study of the water power furnished by the numerous rivers, and the possibility of extending the applications of electricity until the steam engine and the steam locomotive shall have been displaced throughout the state. The fall of the Tieté between S. Paulo and Ytú (65 miles) amounts to more than 560 feet, easily furnishing 75,000 horse power. In its course westward beyond Ytú there are numerous falls and rapids until the river makes its final plunge of 44 feet just before joining the Rio Grande on the western border. The Rio Grande, a far larger stream, makes a similar drop 3 miles above the junction. The volume of water passing over these two falls is but a trifle smaller than that of Niagara, furnishing at least a million horse-power, — four times the amount of power used by all the railroads, factories, shops, and agricultural establishments of the state.

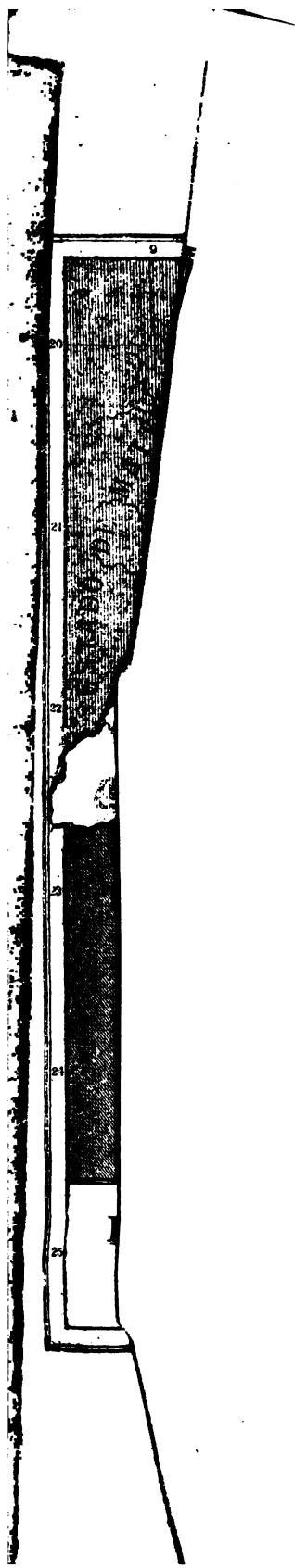
The other rivers flowing through S. Paulo, among which we may mention the Piracicaba, the Mogy-Guassú, the Pardo, the Paranapanema, the Jaguary, all have their rapids and falls. Salto Grande and Palmital scarcely find a rival in Europe, as regards beauty and power. The rivers with their rapids and falls are so well distributed over the entire state that they are within transmission distance of every mile of the trunk lines of railroad, and probably of the branch roads also. As the population becomes denser; as the railroads penetrate vast regions not yet occupied; as larger areas of virgin soil are brought under cultivation; and as new towns and cities with their factories spring up in all parts of the state, may we not expect the streams to be harnessed and to render illimitable service in the industrial development of "the Empire State" of the **Brazilian Republic?**



11







GENERAL MAP
OF THE
RAILROAD AND NAVIGATION SYSTEM
OF THE
STATE OF SÃO PAULO, BRAZIL,
organized and drawn in the Government Inspection Department

— 1905 —

— SCALE ~~mm/mm~~ —

LENGTH OF RAILROADS IN OPERATION SINCE THE FIRST ONE
OPENED, INCLUDING ONLY THOSE OWNED OR GRANTED BY THE

UNION OR THE STATE

A map of the Serra da Baitaca State Park area, showing the coastline and several towns. Key locations labeled include: POUSO ALEGRE, S. RITA, ITAJUBÁ, S. BENTO, SABUGAÑY, CAMBUHY, JARRY, S. JOSÉ, CACAPINHA, JACAREMY, PANTAHYBURA, CRUZES, S. SALLESOPOLIS, VILA BELLA, BAHEPENDY, ARIUJUCA, POUSO ALTO, CHRISTINA, S. LUIZ, CACHOEIRA, LORENA, CUARATINCUETÁ, AREAS, SILVEIRAS, BARREIROS, BANANAL, TRENHE, FUNDAMONHACABA, TAUBATE, CUNHA, PARATY, and ANCHAS. The map also shows the Paraty River (Ribeira de Paraty) and the Baitaca River (Ribeira da Baitaca).

--- LEGENDA